



Understanding what factors affect firefighter use of site-specific risk information

Sara Waring¹ · Georgia Massey¹ · Jeetpreen Kalra¹

Received: 2 November 2023 / Accepted: 11 April 2024
© The Author(s) 2024

Abstract

Fire services have a responsibility to record information regarding known hazards for sites posing unique and substantial risks. Such information is important, both for informing service planning, and for supporting the development of situational awareness and decision-making during emergency response. However, public inquiries and service inspections have raised concerns regarding the effectiveness of systems in place for recording, monitoring, and using site-specific risk information (SSRI). In contrast, a lack of research focus has been directed toward the use of SSRI, limiting the evidence base available for understanding the causes of these difficulties and how they may be addressed. The following study seeks to contribute to developing knowledge by examines what factors affect the use of SSRI across organisational levels and why. Interviews were conducted with 23 firefighters from operational and tactical roles in one region of the UK. Thematic analysis highlighted six key themes: (i) Differences in the use of SSRI across organisational levels, (ii) System accessibility, (iii) Content, (iv) Structure, (v) Quality, and (vi) Training. Findings indicate that SSRI use is affected by the relevance, structure, and quality of information, which are influenced by workload, training, guidance, and system accessibility. During emergency response, information requirements, time and cognitive capacity differ across organisational levels, influencing the extent to which barriers affect ability to use SSRI. The implications of findings are discussed in relation to informing future areas of applied cognition research, and fire sector decisions regarding the gathering and storage of SSRI.

Keywords Site-specific risk information · Situation awareness · Decision making · Firefighters · Information processing · Qualitative research

Fire and rescue services (hereafter ‘fire services’) have a responsibility to obtain and provide information about local risks and hazards for sites that pose unique and substantial risks such as high-rise buildings and industrial premises storing potentially dangerous chemicals. This site-specific risk information (SSRI) is important, both for informing service planning and prevention activities and for supporting situational awareness and decision-making during emergency response (Federal Emergency Management Agency [FEMA] 2018; National Fire Chiefs Council [NFCC] n.d.; Police and Fire Reform (Scotland) Act [PFRA] 2012). Nevertheless, service inspections and public inquiries into

disasters such as the Grenfell Tower Fire have raised concerns regarding the effectiveness of systems in place for gathering, recording, updating, and using SSRI (le Duc 2019; London Fire Brigade 2019; McGuirk 2021). But with little research focus being directed toward the use of SSRI, evidence is limited regarding the causes of these issues and how they may be addressed. We present the first study to examine what factors affect the use and utility of SSRI. Drawing on interviews with firefighters from both operational and tactical roles in one region of the UK, Merseyside, we also consider whether there are differences across organisational levels. Below we discuss existing evidence regarding differences in firefighter decision making across organisational levels and the implications of this for use of SSRI.

✉ Sara Waring
s.k.waring@liverpool.ac.uk

¹ Department of Psychology, University of Liverpool, Eleanor Rathbone Building, Bedford Street South, Liverpool L69 7ZA, England

1 Decision making across organisational levels

Fire services are responsible for responding to a range of emergencies, including fires, chemical spills, and disasters. During this response, firefighters are required to make critical decisions in complex, risky, and uncertain environments (Okoli et al. 2015; Taylor et al. 2019). Fire services also have a statutory duty to identify, monitor, prevent and mitigate community risks as part of their day-to-day service planning activities (FEMA, 2018; Home Office 2018; PFRS, 2012; Welsh Government, 2015). In the UK, fire services typically have nine uniformed ranks that serve either operational, tactical, or strategic roles. Within these hierarchical organisations, firefighters have both emergency response and service planning roles. However, as will be discussed below, differences between organisational levels pose implications for the use of risk information.

For example, firefighters, crew managers, and watch managers serve operational roles. During emergencies, they are responsible for implementing actions at the site of the incident to save lives and reduce harm. Crew managers are also responsible for commanding small incidents that require one fire engine, and watch managers oversee incidents requiring up to four engines. Operational roles are the first to respond, with the initial incident phase often being the most dynamic and rapidly changing. They are required to make large volumes of decisions with very little time to do so (Klein 2010). On a day-to-day basis, firefighters, crew managers, and watch managers also undertake fire and community safety activities, including conducting site visits to record and update SSRI. For larger emergencies, an incident command role is implemented to develop tactical plans for operational firefighters to work to. This tactical role is undertaken by either a station manager, group manager, or area manager depending on the incident size. Tactical roles make fewer decisions and have longer to do so. However, their decisions need to consider broader implications to set operational boundaries for using available resources. On a day-to-day basis, station and group managers manage a station or group of stations and oversee a specific policy area. Area Managers oversee an area of service operations. These managerial ranks are also responsible for reviewing SSRI records.

In the event of very large emergencies, a strategic command role is implemented, with Chief Fire Officers (CFOs), Assistant CFOs, and Deputy CFOs adopting responsibility for setting strategic priorities, allocating resources, and contingency planning (Joint Emergency Services Interoperability Programme 2017). Strategic commanders typically have longer to make decisions than other roles but need to consider the wider implications of the incident and impact

on service delivery. On a day-to-day basis, these senior roles also have overarching responsibility for the fire service and longer-term planning.

As with other hierarchical organisations (Harrington and Ottenbacher 2009), the time available for firefighters to make decisions and the number of decisions that need to be made differs across organisational levels, particularly when responding to emergencies (Alison 2008; Klein 2010). This poses implications for the capacity that each role will have to process information (Butler et al. 2020; Waring et al. 2018). Evidence from the naturalistic decision making (NDM) domain also highlights differences in situational awareness (SA) requirements across organisational levels, which poses implications for the range and detail of information required (Grier 2015; Stanton et al. 2006; Sophronides et al. 2017). SA refers to the ability to (i) perceive elements in an environment, (ii) understand their meaning, and (iii) project what may happen (Endsley 1988; NFCC n.d.). This is vital for enabling firefighters to tailor decisions and actions to reduce risks (Dos Santos and Son 2024; Schulz et al. 2017), including firefighter injuries and fatalities (Bayouth and Keren 2019; Dow and Garis 2013; Okoli and Watt 2018). Evidence highlights that strategic and tactical roles typically require higher-level SA and more detailed information regarding a wider variety of features than operational roles (Grier 2015; Stanton et al. 2006; Sophronides et al. 2017).

Overall, findings suggest that the time available to process information and the level of information needed to inform SA differs across command levels. This poses implications for the types of risk information each role may need and cognitive capacity to process information when responding to an emergency. However, to date, there has been a lack of research directed to understanding whether and how SSRI requirements differ across organisational levels.

2 Site specific risk information

Whilst the ability to source risk information is important for maintaining SA, this can be difficult to achieve during emergencies (Butler et al. 2020; Falkland and Wiggins 2019; Waring et al. 2018, 2020). Fire services have sought to improve information access by collecting and recording details regarding risks and hazards for sites posing substantial and unique risks such as industrial premises storing hazardous chemicals, high rise buildings, and hospitals. UK fire services introduced these recording systems in 2004/2005 to comply with statutory duties created by the Fire and Rescue Services Act 2004 (England and Wales) and the Fire (Scotland) Act 2005 to obtain and record SSRI as part of their provision to deal with emergencies. The process was introduced to fulfil a dual purpose: (i) to support operational,

tactical, and strategic decision-making during incident response, and (ii) to inform service wide emergency planning and prevention activities so that steps can be taken to mitigate the potential impact of risks (NFCC n.d.; PFRA 2012). Similar duties for recording risk information exist in other countries, including the USA (FEMA 2018) and Australia (Eriksen and Prior 2013).

SSRI typically includes a map of the building layout and details regarding building use, construction, risks (including chemicals stored), occupancy rates, contact details for people responsible for the building, operational and environmental information, and considerations for mitigating risks (see Fig. 1 for an example of a risk record; FEMA 2018; NFCC n.d.). In the UK, the process for recording and updating SSRI involves firefighters, crew managers, and watch managers visiting the site to conduct an assessment in conjunction with the site owner/person responsible for managing the site. They complete a risk information form, which is loaded onto their service recording system. These records are reviewed, quality assessed, and signed off by station managers and group managers so that they can then be accessed by all firefighters. Records can be accessed through service computers or networked mobile data terminals loaded onto response vehicles. This allows firefighters to access risk information both before and on arrival at an emergency, which has the potential to improve SA and decision quality (Brouwers et al. 2016; Falkland and Wiggins 2019; NFCC n.d.). In reality, however, questions have been raised regarding the effectiveness of systems for gathering, recording, updating, and using SSRI (His Majesty's Inspectorate of Constabulary and Fire and Rescue Services [HMICFRS] 2019; 2023; le Duc 2019; McGuirk 2021).

To date, little research focus has been directed toward understanding what mechanisms affect the use of SSRI and why. Consequently, the evidence base available for improving the gathering, storage, and use of SSRI is limited. However, findings from applied cognitive research suggest the need to consider human limitations in information processing, attention (focusing awareness), and working memory (ability to keep information in short term memory to process) (Catherwood et al. 2012; Groenendaal and Helsloot 2016; Weick and Sutcliffe 2011). For firefighters working in extreme environments, cognitive capacity is further reduced, creating additional limitations in ability to process information (Gore et al. 2018; Groenendaal and Helsloot 2016; Henderson et al. 2016). Providing too much information can compromise ability to distinguish relevant from irrelevant cues (Marusich et al. 2016; Waring et al. 2018, 2020), develop and maintain SA, and tailor decisions and actions to the situation (Gore et al. 2015; Groenendaal and Helsloot 2016; Klein 2015). Taken together, findings suggest that SSRI use may be influenced by the relevance and conciseness of information presented. However, research is needed to understand how firefighters seek to use SSRI, what information they consider to be relevant, and potential differences across organisational roles.

3 Current research

SSRI is important for fire service pre-planning processes and for informing SA and decision-making during incident management. However, questions have been raised regarding how such information is gathered, stored, and used. The evidence base available for understanding the causes

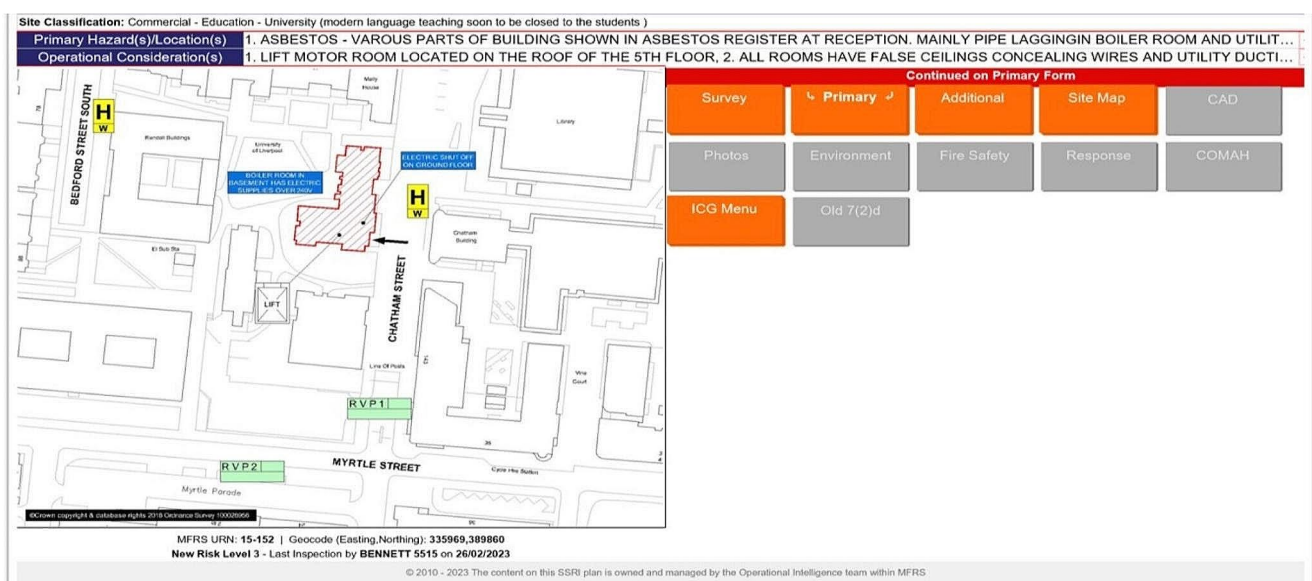


Fig. 1 Example of a SSRI record

of these issues and how they can be addressed is limited. Drawing on the perspectives and experiences of firefighters in operational and tactical roles from Merseyside Fire and Rescue Service, this study aims to address the following questions: (i) what factors affect firefighter use of SSRI and why? (ii) how does the use of SSRI differ across organisational levels? We specifically focus on operational and tactical roles because these firefighters have responsibilities for both the recording of SSRI as part of service planning activities and using such information to inform SA and decision-making during emergencies. Findings pose important implications for fire sector decisions regarding the gathering and storage of SSRI to improve use and utility.

4 Method

A qualitative research approach was used to collect in-depth data to provide a deeper understanding of factors affecting firefighter use of SSRI (Bhandari 2020). An inductive approach was adopted to promote methodological fit (Edmondson and McManus 2007), with meaning being derived from the data collected using semi-structured interviews rather than making a priori assumptions. Questions were designed to explore firefighter experiences whilst allowing flexibility to raise additional topics they perceived to be important (Guest et al. 2013).

4.1 Sampling and participants

Participants were recruited from Merseyside Fire and Rescue Service, which covers both metropolitan and rural areas. A theoretical sampling approach was used to recruit participants based on a set of characteristics to develop and refine theory (Glaser and Strauss 2017), which included being a serving firefighter with first-hand experience of using SSRI. An Area Manager within the service acted as gatekeeper, e-mailing an invitation and information sheet to all firefighters. Those willing to participate contacted the research team to arrange an interview. In line with a theoretical sampling approach, interviews were transcribed and analysed throughout the recruitment process, with further interviews scheduled until data saturation was reached (Boddy 2016; Fusch and Ness 2015). In total, 23 interviews were conducted with male firefighters from across operational and tactical roles (see Table 1).

4.2 Data collection

The interview schedule was developed by SW who has research expertise in human processes in emergency contexts. A stakeholder group of four firefighters (with responsibility for prevention, training, and operational preparedness) was also consulted to ensure questions were relevant and appropriately worded (Gibbs et al. 2007). Questions were structured to be open ended to elicit more in-depth responses, in line with an inductive approach. The interview schedule focused on firefighters' knowledge of SSRI (e.g., *What is site specific risk information?*), when and how such information should be used (e.g., *How should site-specific risk information be used? Can you talk me through an example of how you have used site-specific risk information?*), and factors that affect use (e.g., *What factors are important for improving your ability to use site-specific risk information? Are there any barriers that hinder your ability to use site-specific risk information?*).

Interviews were conducted between April and August 2022. After receiving an invitation and information sheet, firefighters e-mailed the researchers to arrange a suitable time to be interviewed and completed an electronic consent form. All interviews were conducted remotely using Microsoft Teams. Interviews lasted between 30 and 66 min ($M=47.53$, $SD=12.39$) and were recorded, transcribed verbatim, anonymised, and then audio files were deleted. During interviews, steps were taken to improve the trustworthiness of data, including paraphrasing to check researcher interpretation aligned with participant meaning, and asking for concrete examples to sense check (Varpio et al. 2017).

Table 1 Demographic information for participants

Operational Roles		Tactical Roles	
Rank (Quote ID)	Years in Service	Rank (Quote ID)	Years in Service
Firefighter (FF1)	8	Station Manager (SM1)	20
Firefighter (FF2)	11	Station Manager (SM2)	29
Firefighter (FF3)	7	Station Manager (SM3)	14
Firefighter (FF4)	14	Station Manager (SM4)	31
Firefighter (FF5)	9	Station Manager (SM5)	26
Firefighter (FF6)	9	Station Manager (SM6)	21
Firefighter (FF7)	7	Station Manager (SM7)	26
Firefighter (FF8)	11	Group Manager (GM1)	20
Firefighter (FF9)	14	Area Manager (AM1)	23
Crew Manager (CM1)	9		
Watch Manager (WM1)	14		
Watch Manager (WM2)	12		
Watch Manager (WM3)	15		
Watch Manager (WM4)	19		

4.3 Analysis

Interview transcripts were analysed using NVivo software version 12. A data-driven, inductive thematic analysis approach was adopted to explore firefighter perspectives of what mechanisms affect their use of SSRI. Thematic analysis is a form of content analysis that is used to systematically and reliably analyse qualitative data to identify and derive meaning from common themes (Braun and Clarke 2019). However, unlike other forms of content analysis that seek to count frequencies of words and utterances, thematic analysis focuses on identifying common themes based on content to derive meaning. This process of thematising meanings is key to all qualitative analysis, including grounded theory, interpretive phenomenological analysis, and narrative analysis (Holloway and Todres 2003). But thematic analysis differs in that it is independent of theory and epistemology, so can be applied across a range of datasets (Braun and Clarke 2019). This method was selected for use in the current study because it allowed themes to emerge from the data and has enough flexibility and interpretation to answer the research question (Castleberry and Nolen 2018).

Data were analysed in line with Braun and Clarke's (2006) six stage process. This included transcribing interviews to become familiar with content. Next transcripts were coded phrase-by-phrase to derive meaning. In vivo coding was used to ensure that codes were developed using participants' own voices and reflected their perceptions and experiences (Manning 2017). Data that did not relate to the research question were not coded, such as participant background details. Initial codes were compiled into similar groups to develop themes. After each interview, codes were revised to identify commonalities, and to check that themes were relevant to answering the research questions, which is important to the rigour and validity of qualitative research (Castleberry and Nolen 2018).

All interviews were initially analysed by GM and JK and reviewed by SW. Within the qualitative literature, there is debate regarding the use of inter-coder reliability. Some argue that it is beneficial for demonstrating trustworthiness, consistency, and transparency (Connor and Joffe 2020), whilst others argue that the role of qualitative researchers is to apply their expertise to interpret varied perspectives on an issue rather than to reveal universally objective truths (Bauer 2000). In this study, GM and JK each analysed half of the interviews independently and presented descriptions of themes and supporting quotes. All three authors checked theme validity, scrutinising whether the grouped quotes had a logical rationale for how they were organised, and that theme descriptions provided an accurate and meaningful reflection of the collection of quotes. All authors agreed on the grouping of quotes, but discussions helped to strengthen

theme boundaries. A random selection of six participants from across roles were e-mailed theme descriptions and anonymised quotes supporting each theme to review. All participants agreed that the themes accurately represented their views, further demonstrating the reliability and robustness of the analysis (Trainor and Graue 2014).

5 Results

Thematic analysis of interviews identified six themes of importance for understanding what mechanisms affect SSRI use and why: (i) Differences in the use of SSRI across organisational levels; (ii) System accessibility; (iii) Content; (iv) Structure; (v) Quality; and (vi) Training. In total, 84.7% of data were assigned to one of these themes (data not allocated mainly related to participants providing demographic information). Direct quotes are provided to support each theme, with role and rank provided in brackets.

5.1 Differences in the use of SSRI across organisational levels

Across both operational and tactical roles, all firefighters interviewed noted that SSRI provided an important source of information for becoming familiar with a building, its layout, and potential hazards or unique features. They believed that such information could support them in developing situational awareness, and tailoring decisions and actions to promote "*crew safety and minimise risks for the public*". Across roles, feedback acknowledged the infeasibility of all firefighters being able to visit every site posing unique and substantial risks across the region to develop first-hand knowledge of this. In this respect, the recording of SSRI gave all firefighters the potential to access risk critical information about a site that they may not otherwise know about to inform their response to an emergency at that location.

"It's basically gathering as much information as you can for us as operational crew so when we go out, if there's an incident, we have all the information we need to know to be safe and effective. If we need to go into the property and isolate the gas and electricity, we know where they are. At some point, means of escape as well and knowing where people may gather." [Operational, FF3].

"It gives us a deeper insight into what the building may present in terms of hazards for us or challenges." [Tactical, GM1].

"It's a way for us to go into places for the local

knowledge of it. Most firefighters do put them together. Just by going there and carrying out the visit, it means everyone can get a good knowledge of it.” [Operational, FF1].

However, feedback indicated differences between operational and tactical roles regarding when and how they wanted to use SSRI and the feasibility of this. For example, operational firefighters wanted to access SSRI enroute to an incident as part of a quick information gathering process to understand immediate risks. But, during this dynamic phase of an incident, they had limited time available and multiple competing demands. SSRI was noted as taking too long to access and make sense of during this dynamic phase. Instead, they preferred to rely on their own local knowledge, which was quicker and required less effort. Nevertheless, operational roles acknowledged that local knowledge took time to develop. When they were moved to a different fire station in an area, they were less familiar with, they were unable to draw on such knowledge to understand potential risks. They would also try to locate someone who worked at the site to ask for information but noted this could take time.

“Local knowledge, I was quite fortunate I grew up round that area, I did know about the building.” [Operational, FF5].

“On the way to an incident, there’s a lot of information to take in. We need to get there and, you know, deal with the basics of the incident, the type of incident, where somebody’s going to meet you. For example, fire control tends to put that under the message that comes with it. But at that time on the way to the incident, you’ve also got to inform your crew in the back. We’ve got to make sure we know where we’re going, get ready, get dressed and everything. So, at that time it’s certainly not applicable.” [Operational, FF7].

“If someone’s on site, they can tell the OIC [officer in charge] instantly. There’s a fine line between whether site specific risk information is useful. It’s obviously very useful in certain circumstances, but someone on site, a responsible person is going to be gold dust compared to, you know, going on the computer.” [Operational, FF4].

In contrast, firefighters in tactical roles highlighted that tactical command would only be “*stepped-up*” for larger incidents, and they would not be “*part of the initial turn out*” during the dynamic phase of the incident. They discussed having a longer time to make tactical command decisions and “*reflect on the range of information*” available,

including SSRI, compared to operational roles. Whilst firefighters in tactical roles also believed that accessing and making sense of SSRI took time and effort, they had greater capacity to do so. Unlike operational firefighters, tactical roles also discussed the importance of SSRI for informing service planning, including identifying pre-emptive steps for managing risks through prevention and protection work. This is reflective of the policy planning responsibilities more senior managerial roles undertake to achieve service priorities.

“I think we usually turn up after that dynamic phase is finished and then that gives a bit of breathing space to then focus on getting maps up and say downstairs we’ve got the incident command unit, basically computer screens, they get all the plans up and the SSRI, so then we can start going through it.” [Tactical, SM2].

“I guess the best thing for us as fire and rescue service is we can pre-plan. We can identify some of the risks in our station areas so you know if we can anticipate some of that stuff, we can then go gather the operational risk information that’s required.” [Tactical, SM7].

Overall, interview discussions indicated differences between operational and tactical roles in ability to use SSRI to inform decision making during emergency response. As will be discussed below, the accessibility, content, structure, and quality of SSRI affected the ability of firefighters to use this information but there were differences between operational and tactical roles in the extent to which these factors affected the use of these risk records.

5.2 Accessibility

Both operational and tactical roles highlighted that the accessibility of the system used to record and store SSRI affected their ability to utilise this information. Most of the firefighters interviewed perceived the system to be slow to load, difficult to navigate, and “*sometimes crashed*”. However, there were differences across organisational roles in terms of how this affected their functions. For example, operational roles highlighted issues with the system “*freezing*” during site visits, which prevented them from completing the form while the information was to hand. Consequently, they were required to attend sites, take notes, and then return to their fire station to update records on service computers. In addition, the form that needed to be completed was noted to be both convoluted and lacked clarity regarding what information to include. Taken together, these issues resulted in delays to SSRI being updated, along with affecting the

quality and accuracy of what was recorded and increasing workload. Firefighters in tactical roles were responsible for reviewing and signing off SSRI records. They noted difficulties with accessing forms on the system, which created delays in being able to review and approve the new information for it to become accessible by all firefighters.

“It’s a slow, super slow system, isn’t it? It freezes all the time and kicks you out now and then.” [Operational, WM1].

“So those are different places you can click, you’re like “am I in the right form? I’m not in the right forms”. You know what I mean? It’s just so easy to get in the wrong place and get lost on our system.” [Operational, FF6].

“I think it was maybe 2006 when the system we use for accessing SSRIs first came in. It’s a bit clunky and outdated now.” [Tactical, SM7].

“If you said to me now, “load up the system and find me this”, I would probably struggle a bit. I’ve kind of learned sequences as in I get the email, I can log on, I have a list of what I need to check, and I can go through it like that. I am not that familiar with all the ins and outs of the system because I do find it a bit confusing.” [Tactical, SM5].

Across organisational roles, all firefighters highlighted limitations in only being able to access SSRI through service computers and mobile data terminals. Most firefighters had work mobile telephones and believed it would be beneficial to develop secure applications that would allow SSRI to be accessed more readily across a variety of contexts. Operational roles also suggested that such applications could include a more informative step-by-step process regarding what information should be captured in SSRI updates to act as a prompt for improving the quality of what was recorded during site visits.

“Smartphone wise all senior officers have them so there’s no reason why we can’t access it through an app on the phone and have that information to hand.” [Tactical, SM1].

“I think it’s the age of the system, makes it slow. You know what I mean? I think the best way to do it would require massive software changes. Get it out of Excel and maybe put it on a webpage. Or make it like when you buy a new phone, and it takes you through step-by-step. You want to connect to the Wi-Fi, do this.

It could be something like start stage one, have you printed the paperwork? Next page. Then do the survey. Do the primary input. Upload any pictures you’ve got. Do the map. Any CAD plans? Do you need anything else on this? Do you consider this to be finished? Yes, submit, gone.” [Operational, FF2].

Overall, feedback indicated that both operational and tactical roles experienced issues with the system used to record and access SSRI. This created delays in being able to update records and the accuracy and quality of information recorded. Accessibility issues could also increase workload, particularly for operational roles responsible for conducting site visits and recording updates.

5.3 Content

Across operational and tactical roles, firefighters noted issues with the amount of information that was presented in SSRI records. Not all of this information was relevant to all roles, but the system did not allow content to be tailored to roles. All of the interviewees highlighted that being presented with the excess of information contained in records could often be overwhelming and time consuming to process, making it difficult to identify the risk critical information relevant to each role.

“I think you’ve got the information there and its current and it’s relevant...For example, a high rise building that we might have an SSRI for would contain information on person specific issues such as mobility issues or you may have medical issues whereby there’s oxygen in that particular flat.” [Tactical, SM7].

“It might say acetylene cylinders stored in a cage in the yard and then for some reason they put what incident command guide its linked to and well, that doesn’t matter to me. All I want to know is cylinders stored in the rear of the yard, that sort of thing.” [Tactical, SM1].

“It’s just confusing. It’s like information overload and people look at it and just turn away because that’s just too confusing.” [Operational, FF6].

“There’s so much information. There is information overload and because it’s not in a very easy format to follow then you can be overwhelmed with the information that is on there. Like I say, it’s difficult to follow so I’d be reluctant to use it to prepare.” [Operational, FF7].

Firefighters from both operational and tactical roles noted that presenting excessive information was particularly problematic for operational roles because of the time pressure and competing demands they experienced during the dynamic phase of incidents. Feedback indicated that SSRI often contained detailed generic information that is less pertinent to include, such as responding to building constructions and materials that all firefighters already receive training for. The language used was also noted as being convoluted, which made it difficult to understand the information. In addition, the form that needed to be completed to update SSRI records was noted to be both convoluted and lacked clarity regarding what information to include.

“To be honest, not that it’s ever good, but probably things, like building construction and all that because, you know, if it’s on fire, we all train to look at the size and symptoms of if it’s going to collapse.” [Operational, FF1].

“This is what they’ll see in the MDT, that’s their first piece of information and for me that’s too garbled. If the content is not particularly effective, they are just going to switch it back off again or the next time not even bother” [Tactical, AM1].

“That is far too big, there’s far too much going on. This multi-occupied, don’t really get that. Atypically mobile – no one really gets that. I still don’t get it now. Even some of this class explosives, firefighters out there don’t get it.” [Tactical, GM1].

Whilst these content issues were considered to be particularly problematic for operational roles, most firefighters interviewed noted being discouraged from accessing SSRI as doing so could overwhelm them.

5.4 Structure

Feedback among firefighters also highlighted that the layout of SSRI affected use. Both operational and tactical roles believed that the platform layout and how information was presented affected their ability to locate content needed when responding to emergencies. Concerns related to the presentation of large bodies of text in a single colour, font, and format because this made it difficult to locate risk critical information.

“To me, it’s too busy. It’s like when you see a certain colour on the screen. It just blinds you with words. It’s word blindness.” [Tactical, SM2].

“I mean, to be honest, nothing sticks out to me on that form. Like looking at it now, nothing sticks out to me because it’s simple. Black and white. Yeah. It is black and white, to be honest with you, nothing sticks out....It’s just not accessible. If I printed this out on the appliance and maybe in colour, that would help. Everyone’s different though.” [Operational, FF6].

Both operational and tactical roles suggested that the structure could be improved through the introduction of colour coding for different types of information to make this easier to locate. Feedback indicated that this would be especially important for neurodiverse individuals who may “*process information in different ways*”. Tactical roles suggested that colour coding should match the different components of the Joint Emergency Services Interoperability Programme (JESIP) Joint Decision Model (JDM). JESIP was commissioned in 2012 by the UK Home Office to improve disaster response coordination across emergency services (www.jesip.org.uk). The phase based JDM seeks to encourage responders to bring together available information, and coordinate goals, decisions, and actions (JESIP 2017). Firefighters in tactical roles noted that matching colour coding to the JDM would make it easier to locate information and reinforce familiarity with JESIP, which would be beneficial for when they responded to incidents with other agencies.

“We’re looking at how the colour components of the JESIP wheel could fit into the components of the information they need to access... so take action could be initial operational considerations, the hazards fit into the initial gathering of information... people would start to align with their heads that red was information gathering, blue was operational considerations...’ [Tactical, AM1].

“Perhaps colours or fonts or something to make certain bits stand out because I imagine someone with dyslexia would struggle to find their way through that really quick.” [Tactical, GM1].

Both operational and tactical roles noted the need to break up information into “*more manageable chunks*” so that it was less overwhelming to process. Suggestions included having collapsible headings or dropdown menus to improve navigation to the content needed or replacing some text with short videos. In particular, videos demonstrating how to access and use difficult to reach systems were noted as having the potential to be useful (e.g., sprinklers). However, a small number of firefighters questioned whether videos

could become a distraction from focusing on the incident ground.

“Rather than have access to all the information, you just have headings which are collapsible, and you just go, “I want hazard info”, bang, opens up.” [Operational, FF7].

“Let’s say you have a complicated sprinkler system that you need to shut down. A video might be better instead of a load of words and pictures. It would be easier to follow.” [Tactical, SM1].

“It would probably get too involved and you would end up looking at the ToughPad [mobile data terminal] as opposed to looking at what’s there in front of you... I think it’s getting a bit too involved bringing in any kind of videos.” [Tactical, SM6].

Overall, firefighters in both operational and tactical roles believed the way in which SSRI was structured created difficulties for locating the content they needed and could be improved through colour coding, and breaking content up so that different roles could access the information needed.

5.5 Quality

Across roles, firefighters noted issues with the quality of SSRI being recorded, which impacted the utility of such information. Feedback suggested that quality varied, with some site records not containing information about relevant risks present or images not providing sufficient information regarding the location of hazards.

“I think there are currently pictures on there, but I don’t think anyone would look at those pictures because it’d be like a gas isolation, and it would just be a picture of a gas box, but the electric could be anywhere. I mean, it is meant to reference, again, this is a lot of work as well. So, the picture is say 001 gas and then on the map it’s meant to say 001 so you know. But for you to then look at that picture to get the code to cross reference it to the map to say that’s where the gas is. It’s just not very helpful.” [Operational, FF1].

For firefighters in operational roles, feedback suggested that issues in the quality of SSRI were partly the result of a lack of guidance regarding what types of information to include. Both operational and tactical roles noted that workload also played a role. Feedback indicated that there had been an increase in the number of sites with SSRI over time, but many did not warrant such records because risks were

covered by existing general training and standard operating procedures rather than being unique. This was seen as creating unnecessary workload. Operational firefighters also noted that despite “*some sites being more complex and taking longer*” to assess and complete paperwork, they were allocated the same workload recognition. The frequency for updating SSRI also varies depending on site risk level, which could lead to disparities in workload, with fire stations located in areas with many high-risk sites being particularly affected. Tactical firefighters acknowledged that setting targets without consideration of workload could encourage operational roles to focus on quantity over quality, including prioritising “*less complex sites*” and treating SSRI updates as a “*tick box exercise*” (performing an activity to fulfil a bureaucratic convenience rather than serving a higher purpose) rather than ensuring the content was useful.

“To reach targets for SSRIs, they’ll go for an easy one, like a shop. A shop doesn’t need an SSRI ... It’s trying to educate people that we’re trying to get away from that. That target driven mindset.” [Tactical, SM4].

“I think it’s something like 21 a month, which is fine if that’s all you do but incidents get in the way. Other training gets in the way. There are other mitigating factors that can affect whether you make your target.” [Tactical, SM2].

“We now have over 6,000 sites. It’s probably becoming difficult to manage all the operational risk information that we have.” [Tactical, AM1].

“The sheer quality of them gets affected to a point where we’re not even going to see the building, we’re just ringing easy ones up, which we know are not like high life risk or complex buildings.” [Tactical, WM3].

Firefighters in both operational and tactical roles also noted that they did not receive notifications when risk information was updated for each site and doing so “*could become onerous*”. However, they were in favour of being notified about high-risk sites because an incident at these locations could prove to be a significant danger to life.

“Maybe just a little generated email saying this SSRI has been changed and it’s worth a little look for the local station. I don’t really think it would be wise to send it further afield, certainly not across the brigade, you’d just find people numb to be seeing the emails.” [Tactical, SM6].

“If it was a change of the building use type, started

storing hazardous things, I'd want to know. I've been to ones and been on through the system and it's got no risks. And then I've seen acetylene cylinders and things like that. If that went on fire, that's a big risk. So, we'd want to know that was now on site." [Operational, WM2].

Overall, feedback suggests there are disparities in the quality of SSRI. Both the lack of guidance provided regarding what information to include and why, and disparities in workload may affect the quality of the information being recorded.

5.6 Training

Across interviews, both operational and tactical roles highlighted a lack of formal training in how to complete SSRI. Instead, they were expected to "*learn on the job*" from other firefighters. For operational firefighters, this could lead to "*bad habits*", both when conducting site visits, and in using SSRI during incidents. Both operational and tactical roles noted that operational firefighters would benefit from receiving training as part of new recruit content, along with the introduction of e-learning "*refresher training*" that they could "*dip into*" as frequently as they wanted. Feedback indicated that this training should include concrete examples of what "*quality SSRI should look like*" to improve the overall standard.

"I'm sure the new recruits don't do SSRI training when I think they should. They learn the SSRIs when they come on to the station and that's where bad habits are coming in." [Tactical, SM4].

"We don't get an official sit down, this is what an SSRI is, training. You learn as you go in this job. Some things maybe you don't have to do, like the paperwork side of things, but I think because there's a lot of that in the culture, you learn as you go on your job." [Operational, WM1].

"They're called Learning Pro and they cover different topics. So, maybe have an SSRI one that we can do more regularly, a topic where you can go in and if you do it once and you're happy, fine. But you can go in like a dozen times too." [Operational, FF3].

Firefighters in tactical roles also noted the lack of guidance or "*gold standard*" available for supporting the quality assurance process. These more senior roles are responsible for reviewing and signing off SSRI as complete. They noted that the lack of guidance on quality assurance was a

contributing factor to the growing inconsistency in the quality of SSRI. Again, these firefighters highlighted the need for training to help improve the quality assurance process and consistency in standards for signing off SSRI as complete.

"Station managers, for example, because we quality assure them. Let's have a full day on this, go through the whole process, this is how they come to you, this is how you access it, this is the standard it needs to be at. That would be really helpful, so we are all working at the same level, singing from the same hymn sheet." [Tactical, SM5].

There should be formal training, certainly in the quality assurance group, so we are all on the same page. That would filter down, so we are all pushing back for the same thing." [Tactical, SM3].

Feedback indicates that both operational and tactical roles play important parts in the quality of SSRI, with operational firefighters conducting site visits and recording information and more senior ranks reviewing these records. The lack of training and guidance for these functions creates uncertainty regarding standards.

6 Discussion

Despite the potential value of SSRI for informing both fire service planning and decision-making during emergency response, questions have been raised regarding the gathering, storage, and use of this information. This is the first study to examine what factors affect the use of SSRI and why. Interviews were conducted with firefighters from across operational and tactical roles in Merseyside Fire and Rescue Service. Findings highlight that SSRI use is affected by information relevance, structure, and quality, which are influenced by workload, lack of training and guidance, and system accessibility. Findings also indicate differences across organisational levels in the extent that these factors affect firefighter ability to use SSRI. Findings are discussed in more detail below to consider implications for research and practice.

6.1 What factors affect the use of SSRI?

In line with previous public inquiries and service inspections (HMICFRS 2019; 2023; le Duc 2019; McGuirk 2021), findings from this study highlight issues with firefighters being able to use SSRI to inform awareness of the situation and unique risks to tailor decisions and actions when responding to emergencies. However, findings extend on

these previous inquiries and inspections by examining differences across organisational levels in when and how they seek to use SSRI and the feasibility of this. In particular, operational roles find SSRI to be ill-suited for use during the dynamic incident phases due to time pressure and competing demands. In contrast, tactical roles report operating under less time pressure and having greater capacity to reflect on the information included in SSRI. These findings align with previous NDM research, which highlights differences in time pressure and decision making across organisational levels (Alison et al. 2008; Grier 2015; Klein et al. 2010; Waring et al. 2018). In effect, findings from the present study demonstrate differences in information processing capacity across hierarchical roles, affecting ability to use SSRI in its current format.

The findings of the present study also extend on previous literature by identifying the underlying causes of issues with using SSRI. One key issue was the amount of detailed information contained in records. Much of this content was more relevant to senior organisational roles, which tend to require greater detail for a wider variety of features to inform high-level situational awareness (Grier 2015; Stanton et al. 2006; Sophronides et al. 2017). However, much of the content was perceived to be excessive and irrelevant for operational roles, making it more difficult to locate information needed during the dynamic phases of an incident. Previous NDM research highlights that human capacity for attending to and making sense of information is limited and becomes further compromised in extreme environments (Gore et al. 2018; Groenendaal and Helsloot 2016; Henderson et al. 2016). In line with this, current findings highlight that the amount of information contained in SSRI can overwhelm firefighters and compromise ability to distinguish between relevant and irrelevant content (Gore et al. 2015; Klein 2015; Waring et al. 2018, 2020). This presentation of large amounts of information particularly disadvantages operational firefighters who are already operating under cognitive load due to time pressure and multiple competing demands.

Another factor affecting firefighter use of SSRI is the way information is structured. Records consist of large bodies of text that is uniformly formatted, making it difficult to quickly locate relevant information. Feedback highlights that this creates difficulties for firefighters across organisational levels to utilise SSRI but could be particularly problematic for those who are neurodiverse. Neurodiversity is an umbrella term that includes dyspraxia, dyslexia, attention deficit hyperactivity disorder, dyscalculia, autistic spectrum, and Tourette syndrome. Awareness of neurodiversity and differences in behaviour traits and cognition is increasing (Clouder et al. 2020; Pino and Mortari 2014), including the many benefits to neurodiversity in the workplace, such as creative thinking, innovation, and pattern recognition

(Krzeminska et al. 2019). Under the UK Equality Act (2010), neurodiverse workers are also protected against discrimination and employers are expected to make reasonable adjustments. However, fire services have been criticised for the extent to which they are making adjustments, including in the communication of operationally critical information and training (Fire Brigade Union n.d.). To date, limited research focus has been directed to neurodiversity in firefighters and the impact of this on roles. Consequently, the evidence base available for informing decisions regarding making reasonable adjustments is limited. Further research is needed to understand how fire and other emergency, law enforcement, security, and military services can support and harness the skills and abilities of a diverse workforce operating in extreme environments.

Finally, findings highlight that SSRI use is affected by the quality of information presented, including inconsistencies in the types and accuracy of information reported. Findings indicate that issues with information quality, content, and structure are all affected by workload, lack of training and guidance, and system accessibility issues. In effect, a lack of training and guidance for completing, updating, and quality assuring SSRI affects the understanding of both operational and tactical roles regarding what information should be included in SSRI and why. Lack of consideration regarding workload can also compromise the quality of SSRI, leading operational firefighters who are responsible for conducting site visits and recording updates to treat the process as a ‘tick box exercise’ rather than considering what information would be most useful to include. Issues with being able to access the IT system to update information whilst conducting site visits adds to workload and can compromise the accuracy of information recorded. Findings highlight that both organisational and technological issues present during ‘business-as-usual’ service planning operations can affect the ability of firefighters to respond to incidents by compromising the use and utility of risk information.

6.2 Practical implications

The findings of this research have many practical implications for how fire services gather, record and update SSRI to improve the use and utility of this information. Firstly, it is important to ensure that training and guidance is in place that is tailored to all roles within the service. For example, all roles need clarity regarding the purpose of SSRI, the information that needs to be included and why, and how to record this information. More senior managerial roles also require training to clarify processes for quality assuring SSRI. Training delivery needs to be flexible, with in-person sessions for both new recruits and firefighters that are new to quality assurance roles, and online ‘refresher training’

that firefighters can access at any time throughout their career. Guidance should include practical examples of SSRI records that can serve as a template to support firefighters by highlighting the standard of information to include and how this needs to be formatted.

Findings also indicate the need for fire services to focus on how information is structured, including the layout of platforms used to store and access SSRI. For operational roles responding to the dynamic phases of an incident, capacity for processing information is particularly limited, which means that information needs to be relevant, concise, and easy to access. Systems need to allow content to be easily navigated and located, including breaking text up into manageable sections with colour coding or tabs to locate relevant content. It is also important to recognise that information needs will differ across roles and incident phases. Fire services should ensure that systems allow content to be presented in a way that distinguishes between what information is risk critical to each role and incident phase to reduce cognitive load and improve ability to identify and make sense of relevant information. For example, operational roles will require concise information during dynamic phases, but links could be included to more detailed information for senior roles or when time permits. The development of IT systems that allow better access to relevant information during emergencies is an important, growing body of research (Sophronides et al. 2017), including how information is distributed across networks during multi-agency response to disasters (Son 2023; Stanton 2016).

In addition, consideration needs to be given to the allocation of workload for recording and updating SSRI. Within the fire service participating in this study, sites were weighted equally in terms of workload. However, sites may vary in size, risk level, and complexity, all of which affect how frequently updates are needed and how long it will take to conduct checks and record this information. Whilst it remains unclear why this issue has not previously received the attention it needs, a potential explanation relates to changes in resourcing over time. When the process of recording SSRI was first introduced in 2004, fewer sites required such information to be recorded and there were more firefighters employed in the UK (Home Office 2022). The number of sites requiring SSRI has grown over time, whilst firefighter numbers have decreased. This is likely to have placed pressure on the service, exacerbating issues regarding recognition of workload. Findings highlight the importance of acknowledging differences in time required to complete SSRI for different sites to encourage focus on quality rather than viewing the recording and updating of SSRI as a 'tick box' exercise.

Whilst this study focused on factors affecting firefighter use of SSRI, employers in many countries have a legal

responsibility to identify, assess and mitigate risks to protect their employees (Health and Safety Executive n.d., Occupational Safety and Health Act of 1970). This includes implementing systems to record potential risks and hazards, and steps for mitigating them. Understanding what factors affect the use of risk information has broader applications. The findings of this research may therefore be relevant for a wide range of organisations, particularly those that operate in extreme environments.

7 Limitations and future research

This study adopted a qualitative approach to data collection and analysis. Criticisms have been levelled regarding the subjectivity of this methodological approach. However, steps were taken to improve the trustworthiness of findings, both during data collection and analysis. During interviews, researchers paraphrased discussions to provide opportunities for firefighters to correct interpretation and asked them to provide concrete examples to clarify points. During analysis, inter-rater checks were adopted across researchers and themes were shared with a subgroup of participants to verify whether interpretations reflected participant meaning.

It is also important to note that interviews were conducted with firefighters from a single region in the UK. Whilst the collection and use of SSRI is a requirement in fire services across the UK and many other countries, there may be variations in the systems in place for gathering, storing, and retrieving SSRI that affect use differently. However, with criticisms being levelled at a number of services regarding the gathering, storage, access, and use of SSRI, this would suggest issues are widespread. Nevertheless, further research is needed that focuses on interviewing firefighters across a wider range of regions to demonstrate the extent to which current findings apply.

8 Conclusion

Overall, this qualitative study identified factors affecting firefighter use of SSRI and recommendations for addressing issues. Findings highlight that use is affected by the relevance, structure, and quality of information, which are influenced by workload, training and guidance, and system accessibility. Findings also highlight differences in how factors affect SSRI use across organisational levels, with operational roles responding to dynamic, time pressured phases of incidents being particularly affected. These findings pose practical implications for gathering and recording SSRI to improve use and utility. Indeed, many of the recommendations noted above are being implemented in the fire service

the research was conducted with. However, it is important for research to monitor the impact that implementation of evidence-based recommendations have on practice, both for improving service delivery, theory validation, and understanding human behaviour in extreme environments.

Acknowledgements The authors would like to thank Merseyside Fire and Rescue Service and all of the firefighters who took the time to participate in and support this research.

Author contributions SW was responsible for designing the research, developing the interview questions, applying for ethical approval, and writing the manuscript. GM and JK were responsible for conducting interviews. SW, GM, and JK were responsible for analysing data.

Data availability The data for this study cannot be shared openly to protect the privacy of participants and the organisation that the research was conducted with.

Declarations

Ethical approval Ethical approval for conducting this research was granted by the University of Liverpool Ethics Committee.

Competing interests The authors are not aware of any competing interests affecting this research. No funding was received to assist with the preparation of this manuscript. There are no known financial or non-financial interests.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Alison L, Crego J (2008) Policing critical incidents: Leadership and critical incident management. Willan
- Bauer MW (2000) Classical content analysis: a review. In: Bauer MW, Gaskell G (eds) *Qualitative researching with text, image and sound: a practical handbook*. Sage, pp 131–151, pp 131–151
- Bayouth S, Keren N (2019) Fireground cue recognition: effects on firefighter situational awareness when facing high-risk situations in virtual reality. *Int Fire Service J Leadersh Manage* 13:35–44
- Bhandari P (2020) An introduction to qualitative research. Scribbr. <https://www.scribbr.com/methodology/qualitative-research/>
- Boddy CR (2016) Sample size for qualitative research. *Qualitative Market Research: Int J* 19(4):426–432. <https://doi.org/10.1108/QMR-06-2016-0053>
- Braun V, Clarke V (2006) Using thematic analysis in psychology. *Qualitative Res Psychol* 3:77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Braun V, Clarke V (2019) Reflecting on reflexive thematic analysis. *Qualitative Research in Sport. Exerc Health* 11(4):589–597. <https://doi.org/10.1080/2159676X.2019.1628806>
- Brouwers S, Wiggins MW, Helton W, O'Hare D, Griffin B (2016) Cue utilization and cognitive load in novel task performance. *Front Psychol*. <https://doi.org/10.3389/fpsyg.2016.00435>
- Butler PC, Honey RC, Cohen-Hatton SR, Cognition (2020) *Technol Work*, 22(1): 1–12. <https://doi.org/10.1007/s10111-019-00539-6>
- Castleberry A, Nolen A (2018) Thematic analysis of qualitative research data: is it as easy as it sounds? *Curr. Pharm Teach Learn* 10(6):807–815. <https://doi.org/10.1016/j.cptl.2018.03.019>
- Catherwood D, Edgar GK, Sallis G, Medley A, Brookes D (2012) Fire alarm or false alarm?! Situation awareness and decision-making bias of firefighters in training exercises. *Int J Emerg Serv* 1(2):135–158. <https://doi.org/10.1108/20470891211275920>
- Clouder L, Karakus M, Cinotti A, Ferreyra MV, Fierros GA, Rojo P (2020) Neurodiversity in higher education: a narrative synthesis. *High Educ* 80:757–778. <https://doi.org/10.1007/s10734-020-00513-6>
- Connor CO, Joffe H (2020) Intercoder reliability in qualitative research: debates and practical guidelines. *Int J Qualitative Methods* 19:1–33. <https://doi.org/10.1177/2F1609406919899220>
- Dos Santos V, Son C (2024) Identifying firefighters' situation awareness requirements for fire and non-fire emergencies using goal-directed task analysis. *Appl Ergon* 114:104136. <https://doi.org/10.1016/j.apergo.2023.104136>
- Dow M, Garis FCL, Thomas DCL (2013) Reframing situational awareness within the fire service culture. Retrieved from <http://cjr.ufv.ca/wp-content/uploads/2013/11/UFV-Research-Note-Reframing-Situational-Awareness-within-the-Fire-Serv...pdf>
- Edmondson AC, McManus SE (2007) Methodological fit in management field research. *Acad Manage Rev* 32:1155–1179. <https://doi.org/10.2307/20159361>
- Endsley MR (1988) Situation Awareness Global Assessment Technique (SAGAT). Proceedings of the National Aerospace and Electronics Conference (NAECON), IEEE, New York, pp 789–795
- Eriksen C, Prior T (2013) Defining the importance of mental preparedness for risk communication and residents well-prepared for wild-fire. *Int J Disaster Risk Reduct* 6:87–97. <https://doi.org/10.1016/j.ijdrr.2013.09.006>
- Falkland EC, Wiggins MW (2019) Cross-task cue utilisation and situational awareness in simulated air traffic control. *Appl Ergon* 74:24–30. <https://doi.org/10.1016/j.apergo.2018.07.015>
- Federal Emergency Management Agency (2018) Risk management practices in the fire service. Retrieved from https://www.usfa.fema.gov/downloads/pdf/publications/risk_management_practices.pdf
- Fire Brigades Union (n.d.) Dyslexia and neurodiversity in the workplace. Retrieved from <https://www.fbu.org.uk/courses/dyslexia-and-neurodiversity-workplace>
- Fire and Rescue Services Act (2004) Retrieved from <https://www.legislation.gov.uk/ukpga/2004/21/contents>
- Fusch PI, Ness LR (2015) Are we there yet? Data saturation in qualitative research. *Qualitative Rep* 20(9):1408–1416. <https://doi.org/10.46743/2160-3715/2015.2281>
- Gibbs L, Kealy M, Willis K, Green J, Welch N, Daly J (2007) Australian New Z J Public Health 31(6):540–544. <https://doi.org/10.1111/j.1753-6405.2007.00140.x>. What have sampling and data collection got to do with good qualitative research?
- Glaser BG, Strauss AL (2017) *Discovery of grounded theory: strategies for qualitative research*. Routledge

- Gore J, Flin R, Stanton N, Wong BLW (2015) Applications for naturalistic decision-making. *J Occup Organizational Psychol* 88(2):223–230. <https://doi.org/10.1111/joop.12121>
- Gore J, Ward P, Conway GE, Ormerod TC, Wong BLW, Stanton NA (2018) Naturalistic decision making: navigating uncertainty in complex sociotechnical work. *Cogn Technol Work* 20(4):521–527. <https://doi.org/10.1007/s10111-018-0531-x>
- Grier RA (2015) In: Hoffman RR, Hancock PA, Scerbo MW, Parasuraman R, Szalma JL (eds) Situational awareness in command and control. Applied Perception Research. Cambridge University Press
- Groenendaal J, Helsloot I (2016) The application of naturalistic decision making (NDM) and other research: lessons for frontline commanders. *J Manage Organ* 22(2):173–185. <https://doi.org/10.1017/jmo.2015.31>
- Guest G, Namey EE, Mitchell ML (2013) Collecting qualitative data: A field manual for applied research. Sage
- Harrington RJ, Ottenbacher MC (2009) Decision-making tactics and contextual features: Strategic, tactical and operational implications. *Int J Hospitality Tourism Adm* 10(1):25–43. <https://doi.org/10.1080/15256480802557259>
- Health and Safety Executive n.d. Managing risks and risk assessment at work. Retrieved from <https://www.hse.gov.uk/simple-health-safety/risk/index.htm>
- Henderson SN, Van Hasselt VB, LeDuc TJ, Couwels J (2016) Firefighter suicide: understanding cultural challenges for mental health professionals. *Prof Psychology: Res Pract* 47(3):224. <https://doi.org/10.1037/pro0000072>
- Her Majesty's Inspectorate of Constabulary and Fire & Rescue Services (2019) Effectiveness, efficiency and people 2018/19 – East Sussex Fire and Rescue Service. Retrieved from <https://hmicfrs.justiceinspectors.gov.uk/publications/frs-assessment-2018-19-east-sussex/>
- His Majesty's Inspectorate of Constabulary and Fire and Rescue Services (2023) Avon Fire and Rescue Service inspection – accelerated cause of concern. Retrieved from <https://hmicfrs.justiceinspectors.gov.uk/publications/avon-frs-inspection-accelerated-cause-of-concern/>
- Holloway I, Todres L (2003) The status of method: flexibility, consistency and coherence. *Qualitative Res* 3(3):345–357. <https://doi.org/10.1177/1468794103033004>
- Home Office (2018) Fire and rescue national framework for England. Retrieved from <https://www.gov.uk/government/publications/fire-and-rescue-national-framework-for-england--2>
- Home Office (2022) Fire and rescue workforce and pensions statistics: England, April 2021 to March 2022. Retrieved from <https://www.gov.uk/government/statistics/fire-and-rescue-workforce-and-pensions-statistics-england-april-2021-to-march-2022/fire-and-rescue-workforce-and-pensions-statistics-england-april-2021-to-march-2022#workforce-trends>
- Joint Emergency Services Interoperability Programme (2017) Joint decision model. Retrieved from <https://www.jesip.org.uk/joint-decision-model>
- Klein G (2015) A naturalistic decision making perspective on studying intuitive decision making. *J Appl Res Memory Cognition* 4(3):164–168. <https://doi.org/10.1016/j.jarmac.2015.07.001>
- Klein G, Calderwood R, Clinton-Cirocco A (2010) Rapid decision making on the Fire Ground: the original study plus a Postscript. *J Cogn Eng Decis Mak* 4(3):186–209. <https://doi.org/10.1518/155534310x12844000801203>
- Krzeminska A, Austin RD, Bruyère SM, Hedley D (2019) The advantages and challenges of neurodiversity employment in organizations. *J Manage Organ* 25(4):453–463. <https://doi.org/10.1017/jmo.2019.58>
- le Duc F, December (2019) Brighton and Hove's fire chiefs told to improve by official inspector. Brighton and Hove News. Retrieved from <https://www.brightonandhove.com/news/2019/12/17/brighton-and-hoves-fire-chiefs-told-to-improve-by-official-inspector/>
- London Fire Brigade (2019) Grenfell Tower Fire: Preliminary report. Retrieved from https://www.london-fire.gov.uk/media/5087/gtirt19-01534_grenfell_tower_fire_preliminary_report_final.pdf
- Manning J (2017) In vivo coding. *Int Encyclopaedia Communication Res Methods*. <https://doi.org/10.1002/9781118901731.iecrm0270>
- Marusich LR, Bakdash JZ, Onal E, Yu MS, Schaffer J, O'Donovan J, Höllerer T, Buchler N, Gonzalez C (2016) Effects of Information availability on Command-and-control decision making. *Hum Factors: J Hum Factors Ergon Soc* 58(2):301–321. <https://doi.org/10.1177/0018720815619515>
- McGuirk S (2021) Report for the Grenfell Tower Inquiry. Retrieved from https://assets.grenfelltowerinquiry.org.uk/SMC00000046_Steve%20McGuirk%20-%20Firefighting%20report.pdf
- National Fire Chiefs Council (n.d.) National Operational Guidance. Retrieved from <https://www.ukfrs.com/national-operational-guidance-homepage>
- Occupational Safety and Health Act of (1970) Retrieved from <https://www.osha.gov/laws-regs/oshact/completoeshact#:~:text=To%20assure%20safe%20and%20healthful,education%2C%20and%20training%20in%20the>
- Okoli J, Watt J (2018) Crisis decision-making: the overlap between intuitive and analytical strategies. *Manag Decis* 56(5):1122–1134. <https://doi.org/10.1108/MD-04-2017-0333>
- Okoli JO, Weller G, Watt J (2015) Information processing and intuitive decision-making on the fireground: towards a model of expert intuition. *Cogn Technol Work* 18(1):89–103. <https://doi.org/10.1007/s10111-015-0348-9>
- Pino M, Mortari L (2014) The inclusion of students with dyslexia in higher education: a systematic review using narrative synthesis. *Dyslexia* 20(4):346–369. <https://doi.org/10.1002/dys.1484>
- Police and Fire Reform (Scotland) Act (2012) Retrieved from <https://www.legislation.gov.uk/asp/2012/8/contents>
- Schulz CM, Burden A, Posner KL, Mincer SL, Steadman R et al (2017) Frequency and type of situational awareness errors contributing to death and brain damage: a closed claims analysis. *Anesthesiology* 127(2):326–337. <https://doi.org/10.1097/ALN.0000000000001661>
- Son C (2023) Disaster ergonomics: a human factors approach to address escalating challenges from disasters. *Cognition Technol Work* 25:325–344. <https://doi.org/10.1007/s10111-023-00736-4>
- Sophonides P, Papadopoulou C, Giaoutzi M, Sholten HJ (2017) A common operational picture in support of situational awareness for efficient emergency response operations. *J Future Internet* 2(1):110–135. <https://doi.org/10.18488/journal.102.2017.21.10.35>
- Stanton NA, Stewart R, Harris D, Houghton RJ, Baber C et al (2006) Distributed situation awareness in dynamic systems: theoretical development and application of an ergonomics methodology. *Ergonomics* 49(12–13):1288–1311. <https://doi.org/10.1080/00140130600612762>
- Stanton NA (2016) Distributed situation awareness. *Theor Issues Ergon Sci* 17(1):1–7
- Taylor JA, Davis AL, Shepler LJ, Lee J, Cannuscio C, Zohar D, Resick C (2019) Development and validation of the fire service safety climate scale. *Saf Sci* 118:126–144. <https://doi.org/10.1016/j.ssci.2019.05.007>
- Trainor AA, Graue E (2014) Evaluating rigor in qualitative methodology and research dissemination. *Remedial Spec Educ* 35:267–274. <https://doi.org/10.1177/0741932514528100>
- Varpio L, Ajjawi R, Monrouxe L, O'Brien B, Rees C (2017) Shedding the cobra effect: problematising thematic emergence, triangulation, saturation and member checking. *Med Educ* 51:40–50. <https://doi.org/10.1111/medu.13124>

- Waring S, Alison L, McGuire G, Barrett-Pink C, Humann M, Swan L, Zilinsky T (2018) Information sharing in inter-team responses to disaster. *J Occup Organizational Psychol* 91(3):591–619. <https://doi.org/10.3389/fpsyg.2022.1053815>
- Waring S, Moran J, Page R (2020) Decision making in multiagency multiteam systems operating in extreme environments. *J Occup Organizational Psychol* 93(3):629–653. <https://doi.org/10.1111/joop.12309>
- Weick KE, Sutcliffe KM (2011) *Managing the unexpected: resilient performance in an age of uncertainty*, vol 8. Wiley
- Welsh Government, Rescue National Framework (2015) Fire and 2016. Retrieved from <https://www.gov.wales/sites/default/files/publications/2019-05/fire-and-rescue-national-framework-2016.pdf>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.