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ARTICLE

The psychology of interoperability: A systematic review of joint working between the UK emergency services

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Abstract

Emergency responding requires effective interoperability, whereby different emergency teams combine efforts and expertise to contain and reduce the impact of an emergency. Within the United Kingdom, the capacity for the Emergency Services to be interoperable has been criticized by public enquiries. This systematic review had three goals to: (i) define interoperability; (ii) identify the structural principles that underpin interoperability and (iii) identify the psychological principles that outline how interoperability can be achieved. A PRISMA framework was used to identify 137 articles, including 94 articles from the systematic review, 15 articles from grey literature and 28 articles based on author expertise. We identified two structural principles of interoperability: (i) being able to communicate and exchange information effectively; and (ii) having a decentralized and flexible team network. We identified three psychological principles that informed how interoperability might be embedded in the team: (i) establishing trust between team members; (ii) developing secure team identities and (iii) building cohesive goals. We defined interoperability as a shared system of technology and teamwork built upon trust, identification, goals, communication and flexibility. Regular psychologically immersive training that targets these psychological principles will help to embed interoperability into the social fabric of multi-team systems operating in high-reliability organizations.

KEYWORDS

emergency responding, high-reliability organizations, interoperability, multi-team system, teamwork

Practitioner Points

- We recommend a new definition of interoperability as "a shared system of technology and teamwork built upon trust, identification, goals, communication, and flexibility."
- For interoperability to be embedded into the social fabric of an organization, there needs to be a greater understanding of psychology; namely: (i) facilitating trust between team members; (ii) developing secure team identities (i.e., identifying positively with multi-agency colleagues) and (iii) building cohesive goals.
- Future interoperability training must incorporate psychological principles into its design. Regular immersive simulation-based training is essential to test psychological principles in situ and must be followed by providing trainees with the opportunity to reflect upon these principles and unpack them in a psychologically safe learning space.

BACKGROUND

Effective emergency responding is of vital importance to public life. In the United Kingdom, an emergency is defined as "an event or situation that threatens serious damage to human welfare or to the environment in a place in the UK, or war/terrorism which threatens serious damage to the security of the UK" (Civil Contingencies Act, 2004, S1.1). When an emergency goes beyond routine, it is declared as a major incident, requiring "the implementation of special arrangements by one or more Category 1 responders" (Cabinet Office, 2012, pg. 10), such as the Police, Ambulance and Fire Services working alongside Local Authorities, the Environment Agency, Marine and Coastguard Agency and NHS trusts, Public Heath England and Port Health authorities. A major incident requires emergency teams to temporarily combine their expertise to deal with a situation that would otherwise be impossible to manage by a single team, demanding effective collaboration within as well as between teams (Brown et al., 2021; Curnin, Owen, Paton, & Brooks, 2015). This makes them especially challenging workplace contexts by being non-routine and requiring collaboration between sub-teams who generally work independently of each other (Bharosa et al., 2010).

The structure that is typically used by teams operating in complex and demanding task environments is a multiteam system (MTS): a network of teams, working towards one collective goal (e.g., emergency services 'saving life') whilst pursuing various interdependent goals (e.g., police safely cordoning the area, firefighters extracting victims, paramedics treating and transporting patients to hospital; Fleştea et al., 2017; Marks et al., 2001). For an MTS to be effective, sub-teams must align their behaviours, combining their potentially disparate command structures, cultures and procedures (Brown et al., 2021). In the United Kingdom, large-scale disasters, such as the Manchester Arena Bombing (2017), London Bridge Attack (2019) and the Grenfell Tower Fire (2017) amongst others, have raised the profile of the necessity of effective multi-team coordination and, sadly, how its attainment can be elusive in practice.

In this paper, we will systematically review the literature on interoperability by considering the UK emergency services, which have spent the past decade trying to improve joint working between the blue light services via a programme of changes in doctrine and training. In 2012, the Joint Emergency Services Interoperability Programme (JESIP, 2013, 2016a, 2021) was established to improve joint working between the UK emergency services. This was in response to government-level acknowledgement that the emergency services had not been working well together at major incidents. These failings were highlighted in the Pollock Report (2013), which evaluated 32 major incidents from the 1980s–2000s and identified repeated failures of interoperability. Pollock (2013) defined interoperability as "the extent to which organisations can work together coherently as a matter of course" (p. 8) and warned that procedural changes alone were not enough to achieve effective joint working. He argued that, for

interoperability to be fully embedded, there needed to be a concerted effort to shape organizational culture, attitudes, values and beliefs. Simply instructing emergency responders to cooperate better is not enough to achieve the cultural changes required to entrench interoperability within the working practice of responders (Thomas et al., 2010).

The focus of JESIP since its inception has been the development of the Joint Doctrine (2013, 2016a, 2021). This doctrine provides emergency responders with a framework for the actions they should take when working together; for example, ensuring co-location at a scene on arrival, using jargon-free language and adopting a shared "joint decision model" to structure collective decision-making and action. It was intended to supplement agency-specific response plans and the joint training that emergency services organizations already received. However, since its inception, the challenges associated with interoperability have not abated. Indeed, JESIP's focus has been limited to the "blue lights services" despite their regular interaction with non-blue light organizations during emergencies (e.g., Environment Agency, Coast Guard). Further, JESIP training has predominantly focused on command-level decision-makers, failing to recognize the important role that operational staff play in a multi-agency response. The Manchester Arena Inquiry (Saunders, 2022), which evaluated the emergency response to the 2017 terrorist attack that resulted in the deaths of 22 innocent victims, heavily criticized JESIP. Saunders, who led the enquiry, argued that JESIP was not embedded into the "muscle memory" of responders, meaning that under stress they abandoned joint principles and operated in silos. This echoes the warnings by Pollock (2013) that, for interoperability to be achieved, it must be rooted within the organizational culture of emergency workers.

Culture is socially constructed around the beliefs, values and attitudes of an organization's members (Jorritsma & Wilderom, 2012) and is essential to informing how an organization operates. However, to date, culture has not been a focus of JESIP. The consideration of the psychological processes linked to *how* interoperability can be better embedded into the social fabric of an organization is just as, if not more, important than the practical arrangements that JESIP has so far prioritized. Despite JESIPs best efforts, lessons identified from previous incidents continue not to be learned or put into practice. Our systematic review will take the first step in developing our understanding of interoperability through a psychological lens. We suggest that conclusions have application to any high-reliability organization where disparate sub-teams must work together in physically, psychologically and interpersonally demanding contexts (Orasanu & Lieberman, 2011).

Systematic review aims

A core problem with the term interoperability is that definitions of it vary or are omitted entirely. JESIP's own definition ("working together coherently as a matter of routine") is vague and creates potential for confusion and lack of agreement over what joint working means in practice. To improve interoperability, we must first reconsider what it means. Second, there is no clear evidence base for the principles outlined in JESIP's joint doctrine. Although common-sense logic suggests principles like co-location might be important for interoperability, there has been no research to investigate these underpinning principles directly. The principles outlined by JESIP are largely structural and have paid little consideration to psychological and group-level processes that would be trained for in different ways (e.g., trust-building exercises). This review is essential to develop an understanding of what precisely interoperability is and how we can embed it within organizational culture. Taken together, this systematic review has three goals, to:

1. Establish a concrete definition of "interoperability".
2. Identify *what* interoperability looks like with reference to existing structural principles.
3. Identify *how* interoperability can be achieved by categorizing the important psychological principles that underpin it.

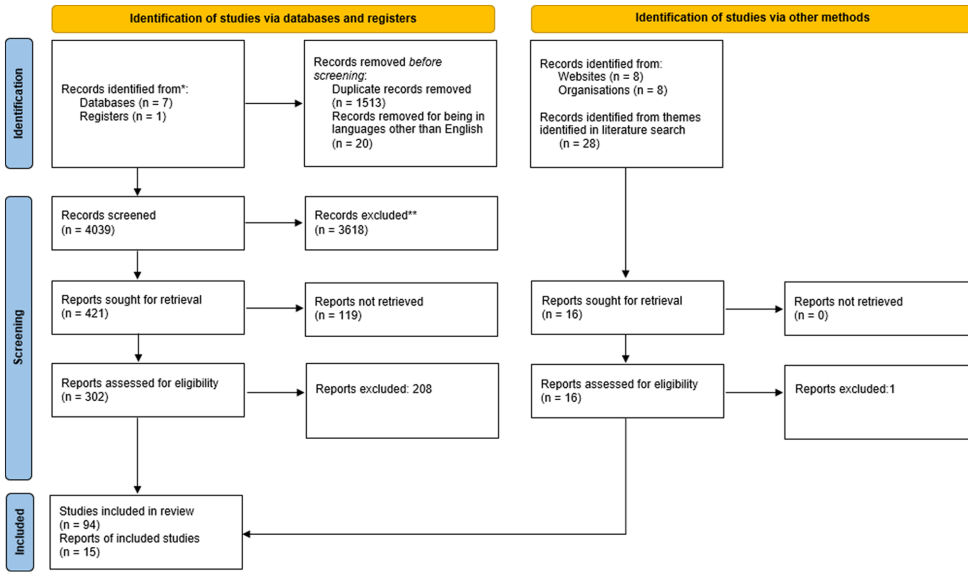

FIGURE 1 PRISMA flowchart. *Keywords: ("emergency" OR "major incident" OR "disaster response" OR "crisis") AND ("interoperability" OR "multi-agency" OR "inter-team" OR "joint organisational" OR "MTS"); **Exclusion criteria included: being irrelevant to the research question, for example, specifically medical, software development, media/journalistic pieces that held no theoretical information or if related to data protection or identity records/data linkage rather than emergency response.

METHOD

Procedure

A systematic literature review using the PRISMA framework (Moher et al., 2015; Page et al., 2021) was conducted to explore the concept of interoperability.[1] This involved three stages: (i) Identification, where all studies and grey literature from keywords and known sources were identified via systematic searching of online databases and through consultation with our steering group members; (ii) Screening, where records were scanned and either excluded through access availability or criteria or kept for the final stage; (iii) Full review, where records were read in full for inclusion or exclusion (Figure 1). Further relevant papers, based on the expertise and knowledge of the authors, were included once the themes from the literature search had been identified.

Eligibility criteria of literature

Search

For the systematic review, a search strategy was applied in OneSearch using known publication keywords, as well as keywords suggested by a steering group with in-depth knowledge regarding the subject. The steering group included subject-matter experts involved in interoperability work (i.e., experienced commanders from the emergency services and experts working in government). This helped narrow search terms to retrieve specific and relevant returns. Initial search terms included: emergency, major incident, disaster response, crisis, interoperability, multi-agency, inter-team, joint organizational and MTS. These

[1]See registration details here: https://osf.io/gtynb?view_only=9da69bba484b4c7cac5402b859a8b086

search terms were linked and modified appropriately for use with: ACM digital, Academic Search Ultimate, Business Source Complete, IEEE_xplore, PsychInfo, Scopus and Web of Science, alongside the original OneSearch. These were chosen to cover the discipline of computing, where interoperability is a key concept, as well as business management and psychology where team and multi-agency working is commonly researched, as well as social topics involving health and emergency response more generally.

The final search terms included the following, linked by the 'OR' Boolean phrase: Emergency, major incident, disaster response, crisis. These were linked by the 'AND' Boolean phrase to the following "OR" terms: interoperability, multi-agency, inter-team, joint organizational and MTS. We made the analytical decision not to include specific social psychological search terms in the process, the advantages of which were two-fold. First, this exclusion meant that we were not imposing what psychological theories we expected to find and would be able to impartially discover what theories were already in use. Second, including psychological search terms would likely further restrict the search and thus significantly cut down article return, potentially excluding relevant papers. Searches were conducted on the 28th of October 2022 and updated on the 10th of November 2022.

In addition, grey literature ($n = 15$) was provided by the steering group, as well as searching known websites for other relevant works, for example, www.jesip.org.uk. It was deemed essential to search beyond purely academic papers and include grey literature to incorporate any reports, guidance documents or inquiries that have relevance to interoperability. Grey literature was used to enhance understanding of how the academic literature fit with real-world incidents, policies and procedures. Finally, further academic papers based on the author's expertise were added once relevant themes had been identified ($n = 28$).

Inclusion and exclusion criteria

Both empirical and theoretical papers were included; this was appropriate due to the need to ascertain the full scope of definitions regarding interoperability. Articles were examined for mention of emergency services/response and that they referenced interoperability or multi-agency working. If there was no mention of these criteria, they were excluded. We decided to focus on emergency "blue lights" services due to the focus that JESIP has on this domain, although the inclusion of non-blue light services might have been included if they were operating alongside blue light services. There was no limit for the year of publication. Papers written in other languages were excluded.

References were downloaded and imported as. RIS files into Zotero. There were 5572 articles upon first retrieval. These were first screened for duplicate articles, with 1513 articles being removed. Following this, 20 articles were removed as they were written in languages other than English. A total of 3618 articles were removed when screened by title and abstract as being irrelevant to the research question, for example, specifically medical, software development, media/journalistic pieces that held no theoretical information, or if related to data protection or identity records/data linkage rather than emergency response. These were excluded manually, reducing the total to 421. Finally, a sift where the full article was accessed was completed, 119 were removed as they were unavailable online, and 208 were sifted out as they were not relevant to emergency response. This left 94 articles for inclusion (see Supplementary Materials), along with 15 grey literature articles, and 28 based on author expertise that supplemented our discussion of core themes ($n = 137$)

Identifying themes

The final papers included in our review were read by the research team who took a thematic analytic approach to combine inductive and deductive knowledge to identify core themes related to interoperability (e.g., Braun & Clarke, 2019). The first pass of analysis was conducted by a researcher who was new to the topic area, to reduce bias and bring a fresh perspective. These themes were presented to the more

experienced members of the research team, who provided further perspectives based on their expert understanding of the academic and grey literature on interoperability. The research team then refined and agreed upon final themes based on discussion and consensus.

RESULTS

Definitions

Out of the 109 articles identified via our systematic review and grey literature search, only 39 offered a definition of interoperability. The remaining papers discussed team or MTS behaviours more generally. From the definitions provided we were able to theme them into three types: (i) government/official definitions; (ii) social definitions (i.e., teamwork, person-based interoperability) and (iii) technological definitions (i.e., computing, information-based interoperability).

Government/official definitions

Out of 15 pieces of grey literature, only five articles provide an explicit definition of interoperability. The first edition of the Joint Doctrine defined interoperability as "the extent to which organisations can work together coherently as a matter of routine" (JESIP, 2013, pg. 2); however, editions 2 and 3 (JESIP, 2021) do not explicitly define interoperability at all. The lexicon of UK civil protection terminology, which has the goal of defining terminology, refers to JESIP, but oddly notes that no definition is needed as it is "included in the acronym". Several academic papers use and reference the JESIP definition (Abdeen et al., 2021; Davidson et al., 2022; McAleavy & Rhisiart, 2019; Tovey et al., 2018). Others referenced the Pollock Report (Pollock, 2013, pg. 4), who use the same JESIP definition save for the syntactic difference "as a matter of course" (Eyre, 2015; Power, 2015, 2018). The National Policing Improvement Agency (NPIA, 2009, pg. 14) defined interoperability as 'the capability of organisations to exchange operational information and to use it to inform their decision-making' (Charman, 2014; House et al., 2014; Wilkinson et al., 2019), providing some insight into how interoperability might be achieved in practice.

Social definitions

The simplest social definition provided was that interoperability meant "cooperation capability" (Rauner et al., 2018). Almost all definitions made explicit reference to "working together", often in pursuit of a common goal: "a measure of the degree to which diverse systems, organizations, and/or individuals are able to work together to achieve a common goal" (Elmhadhbi et al., 2020, p. 3887). Desourdis and Contestabile (2011) introduced the concept of trust within interoperability: "a measure of shared trusted understanding that drives predictable collaborative action towards a common goal" (pg. 27). Some authors further specified the term interoperability to discuss cultural interoperability (Charman, 2014) and holistic interoperability (Desourdis & Contestabile, 2011).

Some definitions referenced emergency teamwork specifically, for example, where interoperability meant "all aspects of collaboration and interaction needed to effectively prepare for, and respond to, disasters and other public health emergencies" (Thomas et al., 2010, p. 173). According to Avanzi et al. (2017, p. 27), "if two or more entities do not have the ability to collaborate, exchange information and coordinate actions, they cannot be considered interoperable." Radburn et al. (2022) provided the only definition to include categories of responder, stating that interoperability involved "the extent to which Category 1 (e.g., the emergency services and local authorities) and Category 2 (e.g., public utility companies) organizations can work together effectively in evolving and complex

circumstances." Sanders (2014) focussed on interoperability within the Police Service specifically as "the ability to access and share information within one's police department, and across other police departments" (p. 469).

Technological definitions

Articles also provided technological and communication-specific definitions. 'Information interoperability' (Seligman et al., 2009) was defined as the ability for two (or more) independent systems to meaningfully exchange information, interact or communicate, and to use the information that has been exchanged to achieve their objectives (e.g., Elmhadhbi et al., 2020). The European Commission (2017) described how technology could be used to support social interoperability as "interoperability is the ability of organisations to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organisations through the business processes they support, by means of the exchange of data between their ICT systems". A commonly referenced definition came from the Alliance for Telecommunications Industry Solutions (ATIS, 2019), which defined interoperability as the ability of two or more systems to exchange information and to mutually use the information that has been exchanged, including the use of systems, units, forces, simulations/models to provide and accept services from other systems and to use the services so exchanged to enable them to operate effectively together. Systems should be able to exchange data, and information directly between them and/or their users, including across different signal formats and applications (Kwon et al., 2009, 2011).

Defining interoperability

Using pre-existing definitions as a basis and incorporating the findings from our systematic review that will be discussed below, we define interoperability as a shared system of technology and teamwork built upon trust, identification, goals, communication and flexibility (Figure 2).

What is interoperability? The underpinning structural principles

The second goal of this systematic review was to identify the structural principles that underpin what a truly interoperable team should look like. This was based on findings from the academic literature on what supports interoperability, along with examination of pre-existing structures identified within the grey literature. For example, JESIP have outlined five core principles of interoperability, including: (i) ensuring co-location at scene; (ii) unambiguous communications; (iii) coordination of efforts; (iv) joint understanding of risk and (v) shared situational awareness (JESIP, 2021). We found in our systematic review that the two most prevalent structural principles were: (1) communication and information sharing; and (2) having a flexible and decentralized team structure.

Communication and information sharing

Emergencies are complex contexts where there can be voluminous, missing, incomplete and contradictory information that must be made sense of to coordinate behaviour. Teams rely on information sharing to build their understanding of the situation (Curnin & Owen, 2014) and must strike the balance between communicating enough detail to inform the behaviour of team members, whilst avoiding unnecessary information overload. Not only must team members communicate information to their own intra-team members, but they must also communicate with inter-team members who might be

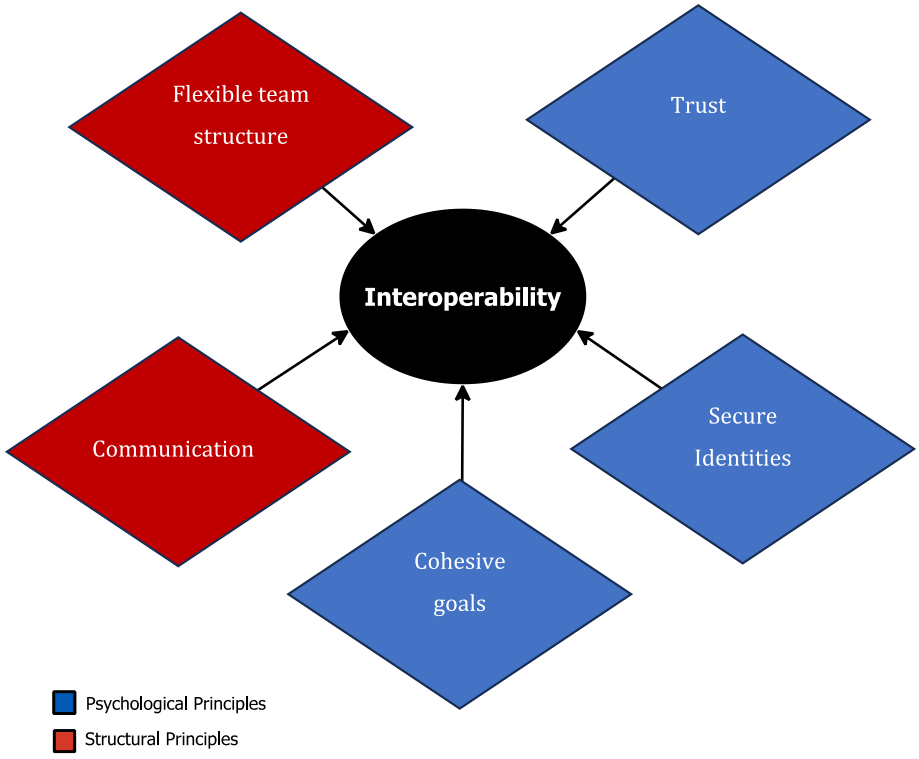

FIGURE 2 The principles of interoperability.

unfamiliar with organisationally specific terminology, acronyms and knowledge (Allen et al., 2014; Curnin et al., 2014; Curnin & Owen, 2014; Strom & Eyerman, 2007; Timmons, 2007; Waring et al., 2018, 2020). For example, the public inquiry following the terrorist attack at the Manchester Arena in 2017 (Saunders, 2022) found that emergency team members did not share a common understanding, or indeed communicate about, key operational terms (e.g., major incident, Operation Plato). This is despite the second key principle of JESIP being to "communicate using language which is clear, and free from technical jargon and abbreviations".

The main advantage of an MTS is to combine expertise to achieve tasks that go beyond the skills of a single sub-team. Each sub-team holds information relevant to their own and other teams' behaviour (Abdeen et al., 2021; Strom & Eyerman, 2007; Wang et al., 2015). Yet, ironically, it has been found that sub-teams working within MTSs tend to prioritize intra-team over inter-team communications (Allen et al., 2014; Wang et al., 2015). This tendency to favour intra-team communications is more likely to happen when under stress (Campbell et al., 2022) and when organizations lack a culture of information sharing (Bharosa et al., 2010; Kwon et al., 2011). Within emergency response contexts, it has been shown that processes for information sharing are not embedded; the Manchester Arena Inquiry (Saunders, 2022) noted there was a failure to identify who needed specific pieces of information, there were no clear radio channels to communicate information, and agencies failed to co-locate at the scene limiting communications. This resulted in serious delays and failures in communication. Often mistakes are made due to failures in how information is utilized by the team (Kwon et al., 2011; Salmon et al., 2011). It is difficult to create a joint-organizational picture if key information is not communicated (Allen et al., 2014). Evidence shows individuals can become overwhelmed and preoccupied by irrelevant or non-critical information (Bharosa et al., 2010; Skills for Justice, 2013). Managing information requires a filtering process with regard to what the information holder (and hence one's own team) needs to know and what other sub-teams need to know (Allen et al., 2014). Cognitive overload can

slow or stop communication and reduce information flow. Thus, it is suggested that clear and effective information exchange and communication practices are a core requirement for interoperability. For example, going beyond JESIP's principle of clear and jargon-free language, to develop widely adopted technological solutions and/or robust evidence-based procedures to optimize information exchange and understanding.

Flexible and decentralized team network

A second structural principle underpinning interoperability is related to the composition of the team network. As emergency teams are, by definition, responding to dynamic and fast-paced emergencies, we argue that flexible and decentralized team networks are central to enabling interoperability by providing a configuration that empowers team members to dynamically react and adapt to the emergency. For example, during certain emergencies, it might be very difficult for all commanders to co-locate at scene if the context dictates time-pressured role-specific demands on a single service (e.g., demands on fire service during a large blaze). A flexible and decentralized team network would embrace context, empowering commanders to make judgements about when role-specific demands might supersede idealized JESIP procedures. At the intra-team level, structures within the emergency services tend to be largely hierarchical (Curnin, Owen, Paton, & Brooks, 2015; House et al., 2014; Tovey et al., 2018), particularly for the Police and Fire and Rescue Services (Tovey et al., 2018), meaning that there is a direct chain of command, often based on rank and/or position. Each emergency service will have a Gold/strategic, Silver/tactical and Bronze/operational commander (Cabinet Office, 2013) who are each responsible for a different tier of command depending on the size and scale of the emergency. When the emergency services work together, commanders from each emergency service at each tier are expected to coordinate their behaviour and make joint decisions, as per JESIP principles (2021). However, the overlapping of command structures across the emergency services is not clear cut. For example, the Fire Service work in small teams who each have a commander. When an incident becomes more complex, the role of incident commander is passed upwards as more senior personnel arrive, meaning that the person delegated as "commander" can change regularly. Compare this to the Police Service which might have multiple commanders working alongside each other. For example, in a firearms incident, the Police will have a tactical commander in charge of the more general police response whilst also having a tactical firearms commander responsible for the firearms team. The assumption by JESIP that these command structures can map together coherently is flawed. It also risks limiting decision-making by imposing a (potentially) mismatched and rigid command structure onto a fluid emergency that would be better served by a dynamic team structure that can adapt to the changing circumstances of the event.

No individual has the time or cognitive resource to process all of the existing information before making a decision (Bharosa et al., 2010; O'Brien et al., 2020). The structure of the team network is essential in mitigating information overload (see previous section), which can be achieved by reducing the 'span of control', that is, the number of people and information one person must deal with (Power & Alison, 2017b). A decentralized structure allows for flexibility whereby decision-making authority and responsibility are distributed throughout the network, ensuring that decisions can be made quickly, rather than being deferred higher up and away from team members (Curnin & Owen, 2014). Team members are empowered to make their own decisions (Pugh et al., 1968) drawing on knowledge/skill within the team rather than rank (Kapucu, 2006). Indeed, some important decisions may be better made by lower ranking team members who have more relevant expertise (Kwon et al., 2011). Furthermore, different elements of an emergency response are better handled by different emergency services due to varying skill sets (House et al., 2014). Commonly, it is assumed that the police will 'lead' the response (Radburn et al., 2022), and this appears in JESIP guidelines for incidents with threat to life (JESIP, 2016b). However, when the power rests with one agency over the others, the scope of multi-agency cooperation is limited because some team members may be ignored or devalued as they are dominated by a central authority (Brown et al., 2021). Allowing decision-makers to utilize their experience, expertise

and confidence in their professional ability can help motivate more timely decision-making (Alison et al., 2015; Power & Alison, 2017b). Thus, a second core structural principle in defining interoperability is the need for a decentralized and flexible team network.

How to achieve interoperability: the psychological principles

A problem with existing interoperability research is that it fails to identify *how* interoperability can be achieved. Identifying the structural principles of interoperability can help us to understand what the team should look like, but this does not tell us very much about how to encourage team members to buy-in to interoperability from a social/psychological perspective. Our third aim in our review was to identify the core *psychological* principles that will help to embed interoperability into organizational practice. Namely, the importance of: (1) Trust (affective, cognitive and group-based); (2) Secure team identities and (3) Cohesive goal setting.

Trust

Trust is defined as the extent to which an individual is confident that they can rely upon, and are willing to be vulnerable to and act upon, the words, actions and decisions of another individual or group (McAllister, 1995; Rotter, 1980). Trust is important for interoperability as it has been shown to influence intentions to collaborate between organizations: organizations who trust one another are open to understanding that joint effort will result in outcomes greater than they could have achieved alone (Curnin, Owen, Paton, Trist, & Parsons, 2015; Mohr & Spekman, 1994). It has been found that without trust, teams tend to focus on task demands instead of teamwork, furthering their own goals rather than superordinate ones (Doyle et al., 2015). Trust between team members supports information sharing and the willingness to accept feedback, hence promoting collaborative working (McAllister, 1995). Without trust, a team's capacity to be flexible to new information is reduced. A lack of trust also increases the risk of silo working (Doyle et al., 2015), reducing interoperability.

Trust is a multi-dimensional construct, which can be split into three types—interpersonal/affective-based trust (i.e., trusting someone on an emotional level); cognitive-based trust (i.e., trusting someone to show reliability, dependability and competence within specific task or role) and group-based trust (i.e., implicitly trusting someone who is a member of your social ingroup; Foddy et al., 2009; McAllister, 1995; Webber, 2008). All three are integral to achieving interoperability.

Interpersonal/affective trust

Interpersonal/affective-based trust is defined as having faith in other team members based on past interpersonal interactions. Fostering direct relationships and familiarity between sub-teams has been proposed as a facilitator for effective inter-team working (Abdeen et al., 2021; Redshaw et al., 2015). Charman (2013, 2015) conducted a series of interviews with Police and Ambulance staff and found that strong working relationships were linked to interpersonal interactions. Specifically, strong working relationships were positively associated with expressions of humour, storytelling, empathy, cynicism, common sense and communication. Repeated exposure to the same people and enduring similar occupational experiences elicited greater familiarity and trust in professional capabilities, as well as learning from individuals and their respective organizations (Charman, 2014). Davidson et al. (2022) looked at COVID-19 Pandemic Multi-Agency Response Teams and found that repeatedly working together and sharing experiences was associated with stronger relationships between Police and Fire responders. Repeated exposure was found to reduce preconceptions about inter-agency colleagues and increase the recognition of similarities with one another, and it was also associated with increased understanding of roles and structures. Participants in this study also reported that working together led to more general positive impressions of other emergency services and they felt that it would improve their multi-agency

working even amongst those they did not know. Thus, not only can interpersonal trust have a positive impact on interoperability at an individual level, it seems that it might also influence cognitive- and group-based trust in those whom they have not previously worked together with.

Cognitive trust

Cognitive trust refers to faith in another that they are able to complete the specific tasks associated with their role (McAllister, 1995; Power & Alison, 2017b). This is essential for emergency teams to function as, even if individuals do not know each other on a personal level, they can trust one another to perform their duties based on an understanding of roles and responsibilities within the MTS (Power, 2018). Emergency teams form under severe time constraints and are usually temporary (Curnin, Owen, Paton, Trist, & Parsons, 2015; Power, 2018) so it is often not possible to rely on interpersonal trust as individuals from different emergency services may not have worked together before (Capiola et al., 2020). A Skills for Justice survey (Parry et al., 2014) found that 20% of commanders had never met their counterparts outside of an incident. As such, cognitive trust can be more important in predicting team success than having trust from personal relationships (Curnin, Owen, Paton, Trist, & Parsons, 2015)

Trust in roles and responsibilities has been termed "swift trust", defined as "a unique form of collective perception and relating that is capable of managing issues of vulnerability, uncertainty, risk and expectations" (Meyerson et al., 1996, pg. 167). Swift trust is built by focusing on specific roles within a team rather than individuals (Meyerson et al., 1996) and is contingent upon having a clear understanding of associated responsibilities (Curnin, Owen, Paton, Trist, & Parsons, 2015). A study in the Isle of Man looking at interoperability between the emergency services during a chemical, biological, radiological and nuclear training exercise found that responders had a strong sense of cognitive trust in each other, volunteer organizations and other support agencies, which led to faster and more effective decision-making (Kirkham, 2009). It was theorized that, because the Isle of Man is a small jurisdiction, dependence on other services in day-to-day operations is high and so exposure to those same services is frequent. Therefore, cognitive trust was built by repeated exposure with other teams.

When MTSs fail to understand the team structure, they have been found to fail. Eklund et al. (2022) found in their research studying barriers to collaboration in emergency response teams that sub-teams hesitated to act if they perceived a task to be better suited to another sub-team. This failure to act was linked to confusion over roles and responsibilities, reluctance to use other professions' knowledge, and a desire to avoid 'stepping on toes.' Sub-teams within an MTS often do not fully understand who is responsible for different tasks (Doyle et al., 2015; Eyerman & Strom, 2008; Salmon et al., 2011). Nor do they fully appreciate each other's capabilities, causing issues with coordination and unrealistic expectations (Iveson, 2022; Parry et al., 2014; Power & Alison, 2017b). A lack of cognitive trust has been linked to poor communication and information sharing as sub-teams have been found to be ignorant of the information that may be useful or necessary to share (Wang et al., 2015). Fundamental knowledge and trust in one's own and other teams' activities, capabilities, roles, strategic aims and management structures is key for reducing uncertainty and improving interoperability (Curnin et al., 2014; Curnin, Owen, Paton, & Brooks, 2015).

Group-based trust

A third type of trust that we identified as being important for interoperability is group-based trust, defined as the tendency to place trust in strangers with whom individuals share a salient social category (Foddy et al., 2009). Group-based trust is the bias individuals have in placing faith in individuals whom they categorize as being members of a common ingroup. Like cognitive trust, group-based trust is useful for establishing swift trust when working with strangers from a common social group (e.g., Hardin, 2001). Group-based trust has been found to be underpinned by two assumptions: that in-group members possess positive qualities, and that ingroup members will act favourably towards individuals they also define as being within their ingroup (Foddy et al., 2009).

Group-based trust is important in team contexts as it can facilitate cooperation between team members who have not previously worked together. Coupled with cognitive trust, team members can engage in complex teamwork with individuals whom they have not previously met due to positive evaluations of these team members based on their shared social group. However, MTSs create added complexity to this effect due to the existence of multiple sub-groups within the team network. As group-based trust is contingent upon an individual categorizing an unknown team member as being part of a common ingroup, how an individual defines their group membership within the wider MTS is central. For example, do they perceive their ingroup to be their sub-team (e.g., Police) or the MTS (e.g., Emergency Services), and thus who do they categorize as being a member of their ingroup. The way an individual identifies with different groups within the MTS is important, which brings us to our second psychological principle: team identification.

Secure team identities

For interoperability to be effective, team members must have secure team identities that allow them to fluidly work with and trust both intra- and inter-team members. Social Identity Theory suggests that people are motivated to define themselves as members of distinct groups: building a sense of "us" and connection with others (Tajfel & Turner, 1979). When people identify strongly with a group, they have a strong sense of connection and common purpose with other members of that group (Davidson et al., 2022; Haslam et al., 2022) and are motivated to further the group's goals. Shared identity can facilitate teamwork with strangers due to the establishment of group-based trust (Foddy et al., 2009). In organizational contexts, the term 'organizational identity' refers to an individual's perception of 'oneness' with their organization and their feelings of meaningful and emotional connectedness (Ashforth et al., 2008; Ashforth & Mael, 1989). Generally, identifying with one's organization has been perceived as adaptive and beneficial in workplace settings, but the influence of identification in more complex MTSs is less well understood.

How a person defines themselves, the organization they belong to, and their role and capabilities, directs how they interpret workplace events (Kwon et al., 2009). Fleştea et al. (2017) analysed a case study of a plane crash to explore the role of identities. Through analysis of interviews and records, they found that when team members were more strongly committed to the overall MTS, rather than their pre-existing sub-team, that planning and coordination became more effective. This sense of connection with a higher order team occurred with increased spatial proximity, clearer collective goals and improved communication across individuals. Davidson et al. (2022) used the Social Identity Approach (Tajfel & Turner, 1979; Turner et al., 1987, 1994) to understand how multi-agency teams assimilated and understood team goals over time. They found that when team members were placed in one analogous team, boundaries between distinct agencies (Police and Fire) dissolved, and participants developed a shared 'identity' as a blue light service with common purpose. This was partly due to shared experiences, the duration of contact and developing personal relationships. Whilst differing subgroup norms and negative preconceptions were difficult to overcome, as well as different perceived work styles—for example, there was a belief amongst the police that the fire service generally has a lower appetite for risk than they do—challenges were successfully mitigated by the above facilitators. Charman (2014) also found that through repeated exposure to similar professional experiences, police and ambulance employees began to identify more as "emergency services" rather than just their single agency, instilling a greater sense of community. Charman (2014) also found a cross-over effect whereby these feelings of affinity expanded to the Fire Service as members of a shared higher order, superordinate "emergency services" group, even if they did not regularly work together.

However, shifting focus towards a superordinate group can have unanticipated negative consequences. When employees strongly identify with their pre-existing subgroup (i.e., Police Service), then shifting focus towards a shared superordinate group (i.e., emergency services) could lead to identity

threat (Conroy et al., 2017). Although group recategorization from "them versus us" to "we" can reduce intergroup bias in some contexts (Gaertner et al., 1993), this shift to a superordinate category by high identifiers with pre-existing identities can lead to rejection of the shared group in defence of these identities (Crisp et al., 2006). In emergency contexts specifically, this could be problematic due to the distinct expertise and knowledge held between emergency groups. Sanders (2014) found that emergency services justified their own actions within a response based on expertise, for example, ambulance staff knowing the best way to treat casualties versus fire staff knowing the best way to extract individuals, rather than seeing these actions as part of one overarching, superordinate team. Furthermore, at a basic visual level, emergency responders wear different uniforms to make them easily recognizable and distinct in their roles (Curnin et al., 2014), which might limit their sense of "oneness" with other emergency workers. Mitchell et al. (2011) found that superordinate identification was associated with more effective MTSs, whereas professional (sub-team) identification was associated with less effective MTSs. They concluded that the utilization of MTSs can have both positive and negative effects on team performance and, to improve teamwork, managers should promote shared vision and interdependence between sub-teams but ensure that these efforts to do not come at the expense of identity threat and blurred professional boundaries. Thus, to build effective interoperability, it is important that team members identify with the MTS, but that efforts to promote identification do not provide an undesirable by-product of sub-team identity threat. Having a secure team identity that embraces both intra- and inter-team membership is essential.

Cohesive goal setting

A third psychological principle that is important for establishing interoperability within an MTS is ensuring that team members have cohesive goals. Goals are important psychological constructs in organizational settings as they help to motivate decision-making and teamwork towards purposeful outcomes (Locke & Latham, 1990; Yates, 2003). Goals can be abstract (e.g., "save life") or concrete (e.g., "prioritise most at-risk patients") and how a team member interprets a goal is important for informing behaviour. To translate goals into action, individuals need to possess clear implementation intentions and knowledge about different actions that can be undertaken to achieve one's goal (Gollwitzer, 1999). The difficulty for goal setting in MTS is striking the balance between holding shared superordinate goals that risk being vague and open to misinterpretation (Locke & Latham, 1990) and having overly specific goals that might lead to selective processing and tunnel vision (Drach-Zahavy & Somech, 1999). Furthermore, due to the structure of the MTS, there is added complexity due to the potential for conflict between personal, organization and collective interorganisational goals (Locke & Latham, 2006).

The central goals outlined within JESIP's joint decision model are to "save life" and "reduce harm". These are sensible superordinate goals for emergency services. However, it has been argued that focusing on these goals can distract from important concrete objective setting. Power and Alison (2017a) found during a simulated counterterrorism exercise that commanders from the three emergency services believed they were working towards a common "save life" goal, but that they translated this goal into agency-specific and potentially conflicting, concrete objectives (e.g., paramedics wanted to save life by getting hands on patients; whereas firefighters sought to save life by taking careful risk assessments). The risk here is that this creates a dangerous gap between an assumption of having shared goals and the reality of intra-agency focussed concrete objectives. If this miscommunication is not spotted, it risks inconsistent behaviour and duplicated or wasted efforts at the multi-team level.

A second issue with the "save life" and "reduce harm" goals is that they are oriented around two opposing regulatory mindsets. "Save life" can be classified as an approach-oriented goal, which motivates individuals to try and maximize outcomes, whereas "reduce harm" is avoidance-oriented goal, which

motivates individuals to avoid causing harm. Approach mindsets have been associated with improved performance compared to avoidance mindsets which have been associated with anxiety and poor performance (Elliot, 2006). Research by Power and Alison (2017a) found that the tendency to focus on approach- or avoid-oriented goals influenced the time it took multi-agency teams to make choices. Those using approach goals made faster choices at the start of the emergency, but later in the exercise, it was avoid-focussed teams who made quick decisions. It was argued that this was due to an increase in competing task demands later on in the incident, which meant shifting regular focus on minimum "least worst" standards led to faster implementation of action. The authors argued that having these two competing goals as central to the JDM was confusing as it blurred regular focus. They recommended that training commanders to improve their awareness of the relationship between contextual demands and goal focus was important to promote more flexible and useful goal setting in the MTS. Thus, to support effective interoperability, responders need to develop a greater understanding about different types of goals and how they interact with contextual demands and associated implementation intentions and behaviour across the MTS.

DISCUSSION

This systematic review had three goals: (1) to establish a concrete definition of the term "interoperability"; (2) to identify *what* interoperability looks like with reference to existing structural principles and (3) to further our understanding of *how* interoperability can be achieved by identifying important psychological principles. We found that existing definitions were vague, simplistic and disparate, making it difficult to formulate a comprehensive understanding of interoperability. JESIP's definition of interoperability as "the extent to which organisations can work together coherently as a matter of routine" (JESIP, 2013, pg. 2) was vague. Other authors (e.g., Desourdis & Contestabile, 2011; Kirkham, 2009) included more concrete psychological components such as the importance of team members having a "trusted understanding" and "breaking down silo thinking". We suggest that, based on findings from this review, interoperability should be more concretely defined as "a shared system of technology and teamwork built upon trust, identification, goals, communication, and flexibility."

One reason why JESIP has not been successful in promoting interoperability is that it has failed to consider *how* to embed interoperability into the culture of emergency services. Organizational culture reflects the contextually rich social life of an organization's members (Meek, 1988). As culture is socially constructed, efforts to achieve organizational change need to be centred around the beliefs and values of its employees (Meek, 1988). Beliefs and values are linked to an employee's sense of "oneness" with their organization (Haslam et al., 2022) and so the way an employee identifies at both intra- and inter-team levels is crucial to predicting their openness to organizational change. We argue that the structural changes that JESIP have thus far prioritized in doctrine and training are not enough to achieve organizational change. Emergency responders must feel committed and socially invested in joint working for it to be properly embedded.

Our review identified three psychological principles that are essential to building an interoperable organizational culture. Specifically: (i) establishing trust across the MTS; (ii) building secure team identities and (iii) ensuring cohesive goal setting. Future training should be designed to explicitly incorporate these principles as learning objectives. For example, designing immersive table-top training about the roles and responsibilities across the MTS to achieve the learning objective of building cognitive trust. Psychological principles should also be incorporated as a social by-product of more regular, high-fidelity practical training. For example, building a sense of shared identity and group-based trust through repeated exposure to members of that group during simulated or live exercises.

A limitation with recommending the need to train these types of psychological principles is that there is very little evidence-based research that describes how to implement this type of training, especially when training goals (e.g., better interoperability) are difficult to evaluate objectively. Metz et al. (2022)

argue that when organizations are seeking to implement changes in their ways of working that change implementation is more successful when trust exists between implementation stakeholders (i.e., individuals and groups who have interest in the implementation results) and implementation support practitioners (i.e., professionals supporting the implementation of change). Trust building can be achieved by adopting relational strategies, such as showing vulnerability and authenticity by providing a safe space for honest discussion during training, or through technical strategies, such as having frequent and regular interactions. They promote an ethos of co-creation and humility between implementation stakeholders and support practitioners by addressing power differentials and developing shared goals. They suggest that adopting strategies to build trusting relationships promotes greater capability, opportunity and motivation to achieve change. In applying this to interoperability training, we argue that strategies such as those identified by Metz et al. (2022) would have a dual positive effect in promoting both trust between team members, and trust in the interoperability training itself.

It is important to note, however, that debate about how to best implement training and promote change towards interoperability remains purely academic if regular training does not occur. A persistent problem with training in emergency contexts is that not enough multi-agency training or exercising takes place, and not all relevant people or agencies are routinely invited or available to take part due to resource limitations (e.g., Abdeen et al., 2021; Curnin et al., 2014; Thomas et al., 2010). For example, the focus of JESIP thus far has been on command-level blue light responders, but for interoperability to be achieved it must reach beyond these arbitrary closed loops to embrace non-blue lights and operational responders. For ambulance workers specifically, it has been found that they rarely have the opportunity to engage in multi-team training due to service demand and so training is often limited to specialist resilience staff (Tovey et al., 2018). Furthermore, procedural documents are unlikely to be read by all staff, due to lack of time or awareness meaning that much written instruction, even if comprehensive, is not well utilized (Iveson, 2022; Skills for Justice, 2013).

With that in mind, we argue that the future of interoperability training must strike the balance between academic training ideals and the practical demands of the emergency services. Although large-scale live exercises that physically replicate real-world emergencies might be perceived to be the gold standard, they are expensive, difficult to organize, infrequent and only offer training benefits to those few who are available to take part. We suggest that simulation-based training (see, Brown et al., 2020 for a review) is the key to future interoperability training; providing a psychologically immersive environment within which to regularly train and develop the psychological principles of interoperability. Future work should look to develop a catalogue of training simulations that are designed to specifically cultivate one or more of the psychological principles we have identified. For example, building "wicked problems" that have no right or wrong answer into a simulation, and then asking team members to unpack how trust and team identification influenced their decision-making during the training debrief, importantly within a psychologically safe space that allows participants to truly reflect on their learning (Metz et al., 2022).

CONCLUSION

This review found that a single, clear definition of interoperability did not exist. We have defined interoperability as a shared system of technology and teamwork built upon trust, identification, goals, communication and flexibility. We found that the structural principles of interoperability were associated with effective communication and information exchange, whilst adopting a decentralized and flexible team structure. However, to ensure that interoperability is properly embedded within an organization's culture, we must also consider psychological principles. We propose that interoperability training to build trust, secure team identities and knowledge about goal cohesion is key to achieving this goal. Specifically, this can be achieved through regular high-fidelity simulation-based training that seeks to target these principles within a psychologically safe learning environment.

AUTHOR CONTRIBUTIONS

Nicola Power: Conceptualization; formal analysis; funding acquisition; methodology; supervision; writing – original draft; writing – review and editing. **Jennifer Alcock:** Formal analysis; investigation; writing – original draft; visualization. **Richard Philpot:** Conceptualization; funding acquisition; methodology; writing – review and editing. **Mark Levine:** Conceptualization; funding acquisition; methodology; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

All authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Data S1

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