Facilitating teamwork in emergency management: The team process checklist

Chris Bearman [*], Peter Hayes, Mark Thomason

Central Queensland University, Appleton Institute, Australia

ARTICLE INFO

ABSTRACT

Emergency management (EM) teams typically operate in complex dynamic environments where they need to synthesize incomplete, contradictory or overwhelming amounts of information into intelligence and produce outputs in a short time-scale. Independent inquiries following large-scale emergencies highlight the central role that team processes such as communication, coordination, and cooperation play in enabling the effective performance of teams. This article describes the development and evaluation of the Team Process Checklist (TPC). The TPC is a 17-item checklist that is designed to help observers and/or team members better understand and manage EM teams both in real time and after the event (in debriefs and after action reviews). Items for the TPC were identified in the literature on communication, coordination and cooperation and then developed through five different regional coordination center (RCC) exercises by observers who used the TPC to evaluate the teamwork of the RCC. Following the development phase four evaluation studies were conducted with EM personnel. In these studies the TPC was rated as having *very good* usefulness, clarity, and comprehensiveness. The TPC therefore shows considerable promise as a simple, straight-forward way to help people in EM better understand and manage their teams in real time and after the event.

1. Introduction

Emergencies are generally managed by teams of people who operate in a structured hierarchy. Successful management and resolution of emergencies is reliant upon effective teamwork [1,2]. Emergency management (EM) teams work at multiple levels spanning response (on-scene operational), incident management (tactical) and coordination (strategic) [3]. EM teams not only need to understand and manage their own team processes, they also need to coordinate effectively with teams up and down the chain of command and laterally with other agencies. Brown et al. [4] highlight how large scale emergencies such as terrorist attacks, pandemics, severe weather and bushfire events require emergency teams to engage in swift and coordinated action. This may require the responding emergency organizations to form a multi-team system (MTS) to achieve this. Drawing on earlier work by Mathieu et al. [5] and Shuffler et al. [6], MTSs are described by Brown et al. as 'a network of component teams working to achieve separate, but related objectives within a framework of overarching goals' (pp.591-592). The use of MTSs enable EM organizations to bring together the skillsets required to manage the challenging and complex task environments created by large scale emergencies [7,8]. These EM environments pose a variety of teamwork related challenges such as competing priorities, and maintaining effective coordination,

communication and cooperation [9–15]. Despite widespread use of MTS in EM, there has been limited research focused on MTS in these contexts [4,16]. The EM literature has instead largely used more traditional teamwork concepts and focused on issues such as interoperability between response teams (e.g., [17–19]). An important aspect of MTSs that differs from traditional teams is the requirement to collaborate both within and across teams whilst component teams simultaneously continue to achieve their own objectives and contribute to the superordinate goals for managing the incident [5,8,20,21].

As a team carries out its function in a complex dynamic environment (such as emergency management) there will be times when it is under pressure from having to synthesize incomplete, contradictory or overwhelming amounts of information into intelligence and the need to produce outputs (such as incident action plans, warnings to the community, etc.) in a short time-scale [22]. EM teams, like other command and control teams, are typically heterogeneous, form a number of sub-teams, process large volumes of information and may not be physically located together [23]. If a team is not physically located together then additional problems may be caused by loss of visual cues, restricted information flow and a lack of immersion [23]. EM teams are also likely to be temporary and have a membership that is both fluid and at times inexperienced [24]. These pressures are not particularly unusual or abnormal but to a greater or lesser extent are a normal way in which teams operate in such environments. However, if the team does not manage these pressures effectively they can lead to a dysfunctional team and an impaired operational response [1]. In order to be resilient to these disruptions in team functioning the team needs to be aware of and manage their own internal processes, and in particular the processes of communication, coordination and cooperation. These internal team processes (or teamwork) essentially require people to manage clusters of inter-related knowledge, skills and attitudes in ways that facilitate team sensemaking, goal formation, plan construction and decision making in a complex dynamic environment [25]. This is the hallmark of high functioning teams [25].

Communication, coordination and cooperation are critical for intra-team and inter-team performance in MTSs. Weaver et al. [26] argue that improvements in the safety and quality of patient care requires 'effective teamwork at the bedside, and effective communication, cooperation and coordination among teams across the organization' (p. 39). Similarly, effective communication, cooperation and coordination play a central role in the performance of space missions [27], military MTSs [28], and EM MTSs [17]. One reason for the importance of communication, coordination and cooperation in MTSs is goal interdependence [5]. Establishing, maintaining and sharing common goals requires a mutual exchange of information (communication) within the MTS network, and these interactions facilitate coordination and cooperation [17]. de Bruijn [29] have observed that a lack of or unclear superordinate goals can reduce MTS cooperation.

Numerous independent inquiries have highlighted the particular teamwork challenges for EM and have identified consistent shortcomings in communication, coordination and cooperation. For example, during the 2009 Australian Black Saturday fires coordination problems between different incident management teams (IMTs) led to a situation where public warnings were not sent in a timely manner [1]. During Hurricane Katrina emergency response operations were undermined by communication, cooperation and coordination problems [30]. A lack of cooperation in sharing key information hampered the coordination of search and rescue operations and limited opportunities to acquire and utilize much needed additional resources [31,32]. A review of 32 major UK emergencies between 1986 and 2010 by Pollock [33] found a consistent and repeated pattern of communication failures in the management of these incidents. Cooperation and coordination were also clearly identified as problematic in a number of the emergencies reviewed. The continuing recurrence of problems with communication, coordination and cooperation in inquiries and investigation reports suggests there are significant issues that need to be managed and a significant opportunity to improve these processes.

There is a clear need to better manage team processes (such as communication, coordination and cooperation) within EM teams. However, there is typically little formal guidance on how to manage these processes in many EM agencies [22]. Interviews with personnel in EM agencies in Australia and New Zealand conducted by the authors found that all of the agencies used formal incident control systems (such as the Australasian Inter-Service Incident Management System [34]). These systems were used to manage the structure of teams, define a standard set of roles and responsibilities (e.g. logistics, operations, planning) and to provide some general principles of teamwork (such as span of control). Some agencies also used software to manage workflows and communications between team members. However, none of the agencies interviewed had policies and procedures for managing detailed internal team processes (like communication, coordination and cooperation). It should also be noted that predefined roles and responsibilities state how the role should be carried out, which can be very different to how the role is actually carried out during the management of an emergency. During an actual emergency roles and responsibilities may become blurred as people drift into other roles, lack experience and/or try to help others who are overwhelmed. Bearman, Rainbird et al. [22] have argued that the lack of formal guidance from agencies on team processes 'restricts the ability of senior officers to optimize their team's capabilities, enhance functionality, or conversely, foresee potential disruptions to their team's operational response' (p.256).

One way that teamwork has been managed in other domains is through the use of checklists. These are commonly used in sectors such as aviation, medicine and nuclear energy [35]. Checklists benefit users by supporting and enhancing cognitive processes (such as memory) that may be compromised while undertaking demanding or complex tasks [36]. Checklists enable standardized performance; support adherence to recommended practice; reduce the adverse effects of stress, fatigue and distraction; and promote communication among team members [35]. A meta-analytic study undertaken by Lyons and Popejoy [37] found that use of a surgical safety checklist was associated with large improvements in the quality of teamwork and communication. Checklists specifically designed to help teams diagnose and monitor their teamwork skills have now been developed in a number of domains (e.g. [38]).

Burian et al. [39] have defined a five stage framework for the checklist lifecycle comprising: (1) conception, (2) determination of content and design, (3) testing and validation, (4) induction, training and implementation, and (5) ongoing evaluation, revision and possible retirement. This paper will consider the first three stages of this framework in developing a checklist to help people better manage teamwork in EM situations and make some suggestions about the fourth stage (induction, training and implementation).

McLaughlin and Byrne [36] have emphasized the importance of checklist designers considering the most appropriate support options for the functional task environment concerned. Burian et al. [39] outline two pertinent dimensions that need to be considered. The first is the temporal/behavioral dimension addressing whether the checklist is to be used in real time to standardize actions and gather information or after the event to evaluate information, actions and the situation. The second dimension considers whether the checklist is to aid memory or to facilitate decision making. Checklists may be positioned on the continuum between these poles as is the case for the WHO Surgical Safety Checklist. The WHO Surgical Safety Checklist blends both real time and after the fact elements and has both memory and decision aid features. Gawande [40] has developed a 'Checklist for checklists'. Although a number of this checklist's points focus on the format, Gawande does highlight the importance of identifying a clear and concise purpose for the development of a checklist.

This paper then seeks to develop a prototype checklist that provides a diagnostic tool to help people in EM better understand and manage the team processes of communication, coordination and cooperation both in real time and after the event. The checklist is aimed predominantly at people who work in multi-team system environments (such as incident management teams, regional coordination teams and state coordination teams), although it should be general enough to be used in other EM environments (such as emergency responders). The checklist should be diagnostic in that it should help the user to diagnose potential problems in team processes so that solutions can be implemented, thus supporting decision making about teams. The checklist is also a memory aid in that it will provide the user with a prompt (memory aid) to identify which key teamwork behaviors are present or absent, thus helping the user to assess how effectively the team is working and any problems. As such this tool should be able to be used by both observers and members of the team in real time during an operation and as a tool to reflect on team performance in after-action reviews and debriefs. This requires the development of a checklist that is brief, simple, easy to use and contains concepts that can be observed by someone who is not an expert on teamwork. This means that the checklist needs to be useful, clear and comprehensive (i.e., can capture all of the good and bad elements of teamwork) as evaluated by its potential users. While it is unlikely that a checklist of this type will identify all the things that can potentially go wrong in a team it should identify a comprehensive range of issues.

The research question that guides the research presented in this paper is therefore: Is it possible to develop a diagnostic checklist for emergency management based on communication, coordination and cooperation that is useful, clear and comprehensive as evaluated by potential users? We turn next to the literature on communication, coordination and cooperation to identify items that could form the basis of such a checklist.

2. Literature review

2.1. Communication, coordination, and cooperation

There has been a great deal written about teams and teamwork from a variety of perspectives (such as human resources, sociology, psychology and management) and in diverse domains (such as manufacturing, health, aviation and military). The potential candidates for inclusion in a checklist that helps EM teams to function more effectively are legion and it is not our intention to review that voluminous literature here. For recent reviews of the EM literature in relation to teams see Bearman, Rainbird et al. [22], Power [24] and Hayes et al. [41]. Our focus here is on the processes of communication, coordination and cooperation because are critical processes in teams and they potentially provide us with clear observable features that give us a window into how the team is functioning [22]. Communication, coordination and cooperation are central concepts in the literature on teamwork, forming the basis of both investigations of incidents (cf [1]) and many models of teamwork [25,28,42,43]. They are also commonly identified as causal or contributory factors in many investigations into operational incidents in EM (e.g., [44–48]).

Other teamwork processes (such as leadership, situation awareness and goal conflict) have been proposed as key processes in MTSs [6,49] and are potentially relevant to EM. However, these concepts can be difficult to observe by a non-expert on teamwork and including them in the teamwork checklist would require a much more complex and lengthy tool that would be harder to use in the field. Communication, coordination and cooperation are required by all team members at all times and are the enablers of other processes, such as leadership, conflict resolution, team situation awareness and effective decision making. For example, accurate and timely communication of information underpins team situation awareness, good cooperation includes managing conflict and effective leadership is built on good communication, coordination and cooperation. We have therefore chosen to focus on the three processes of communication, coordination and cooperation as the basis for the teamwork checklist.

Communication, coordination and cooperation are interdependent team processes. Fuks et al. [50] used an information systems perspective to map the relationship between these three processes for various situations, such as conversation for action, adaptive workflow, informal communication, and command and control activities. Fuks et al. highlighted how communication, coordination and cooperation processes interact and operate in an iterative manner to enable shared awareness and collaboration. Further evidence for the importance of communication, coordination and cooperation comes from Crawford's [51] review of experimental game theory research. Crawford highlights how these three processes play a key role in building and maintaining effective human relationships. Badiru and Racz [52] propose the use of the Triple C model of communication, cooperation and coordination to support rapid emergency response. Communication helps emergency teams address the questions of *what* and *why*, cooperation helps emergency teams address the questions of *who* and *how*, and coordination helps emergency teams address the questions of *where* and *when*.

A recent study by Brown et al. [4] provides insights on some of the teamwork requirements for teams operating in multi-team systems (MTSs). This study investigated the coordination and communication requirements for EM MTSs undertaking a large-scale immersive simulation-based exercise. The study's thematic analysis of communications identified three positive coordination behaviors exhibited by component teams, namely joint decision making, sharing resources and sharing task-related information. The study also highlighted three negative coordination behaviors, namely role uncertainties, decision uncertainties and conflicting

priorities. Table 1 provides a brief description of each these behaviors.

Review of the positive and negative behaviors identified by Brown et al. [4] align with the team processes of communication, coordination and cooperation. The three positive behaviors: joint decision making, sharing resources and sharing task related information rely on cooperation, timely and effective communication, and recognition of the need to coordinate decision making. Similarly, the negative behaviors of role uncertainties, decision uncertainties and conflicting priorities will be exacerbated by ineffective communication, poor cooperation and inadequate coordination at the individual or team level.

Perhaps the most detailed explanation of the concepts of communication, coordination and cooperation has been proposed by Wilson et al. [28] and Salas et al. [25]. A description of each of the three processes based on this work follows.

2.1.1. Communication

In its simplest form communication is the transfer of information between two individuals, typically described as sender and receiver [53]. This description reflects the classical or traditional view of communication as static and emphasizes the role of the sender in a process orientated towards distributing messages to receivers [54]. This traditional view posits receivers as largely passive participants who are assumed to accept and act on these messages. This approach is epitomized by Berlo's [55] sender-message-channel-receiver (SMCR) model. The SMCR model suggests communication follows a relatively simple linear process. Sellnow and Seeger [54] note that as the field of communication has grown, a broader range of perspectives has developed to describe communication as a more dynamic and transactive process. Barnlund's [56] transactional communication model characterizes communication as a complex process that is dynamic, continuous and circular. Communication is thought to have three main functions: regulating the behavior of self and others; linking individuals with others and their environment; and enhancing mental processes and capacity [57].

From a teamwork perspective, Salas et al. [25] emphasize the central role communication plays in forming and modifying the attitudes, behaviors and cognition of team members. This perspective underlines the role communication plays in supporting teams to adapt and respond to changes in the operational environment. Meta-analytic evidence shows that information sharing in teams (particularly the sharing of unique information) is positively related to team performance [58]. Team communication plays an important role in shaping how information flows within a team and can influence the ability of members to successfully work together to achieve goals [25,59].

The term communication is often used as a catch-all to describe its many aspects. However, Wilson et al. [28] observe that it is important to be more precise when describing communication processes. Drawing on research undertaken by Smith-Jentsch et al. [60], Wilson et al. [28] identified three specific aspects of communication important to teamwork in high pressure settings: information exchange, phraseology and closed-loop communication. Effective information exchange occurs when appropriate information is passed on to the right person without prompting and there is provision of periodic situation updates highlighting the bigger picture. Information exchange occurs through various verbal and non-verbal channels and may include updates on the evolving situation, feedback on how well response activities are working and notification of changes in tactics or strategy. Information exchange provides teams with sound and accurate information central to building and maintaining a shared understanding of the situation. The second aspect of team communication is phraseology. This refers to using the correct terminology, providing complete standard reporting, ensuring communication is clear and concise and avoiding unnecessary chatter. Use of appropriate phraseology supports efficient communication and reduces the likelihood of misunderstandings and the need to clarify or resend information. Closed-loop communication is the third aspect of team communication. This aspect of communication addresses whether the information provided to others has been received and interpreted correctly. The use of closed-loop communication has been found to distinguish effective teams from less effective teams [53,61]. As its name suggests the closed-loop technique has three steps. First, the sender transmits the message; second, the receiver confirms receipt of the message; and third, the sender verifies that the message has been received and interpreted correctly. When there are problems in any of the three aspects of communication, breakdowns can occur that may compromise shared cognition and hence team performance [28,62].

2.1.2. Coordination

The second element of teamwork identified by Wilson et al. [28] was team coordination. This element captures the teamwork processes that enable teams to effectively organize the timing and sequence of interdependent tasks and activities [63]. Similar to communication, ensuring coordination among team members is not simple. This is because team coordination requires all team members to act in an appropriate and timely manner [42]. Wilson et al. [28] observed that team coordination relies on members: seeking assistance when overloaded; offering assistance when others are overloaded; monitoring other team members' performance so

Table 1
Positive and negative coordination behaviors for MTSs identified by Brown et al. [4].

Positive coordination behavior	Description
●Joint decision making	Actively working together with other teams or agencies to implement a decision
●Sharing resources	Offering resources to assist other teams or agencies within the MTS
●Sharing task-related information	Actively sharing team or agency specific information to improve shared situation awareness
Negative coordination behavior	
●Role uncertainties	Confusion about one's own role or the role of others
●Decision uncertainties	When decision making lacked clarity and/or there was indecision
●Conflicting priorities	When team members attempted to emphasize their own team or agency's priorities

that problems can be quickly identified and resolved; adapting to changes in the situation; and sharing knowledge of the task, team, and environment. Wilson et al. [28] acknowledged that other team competencies also play a role in team coordination such as task knowledge, teammate knowledge, and adaptability [64,65].

Salas et al. [25] propose that coordination is the primary driver enabling positive team outcomes. A systematic review and integration of 29 teamwork behavior models undertaken by Rousseau et al. [66] found that coordination was frequently cited as a crucial element of teamwork. To ensure coordination is achieved teams are required to orchestrate the order and timing of interdependent actions [63]. Coordination can take various forms depending on whether team members are working on the same task, complementary tasks or interdependent tasks [67]. Team coordination may be explicit or implicit (e.g. [68]) and it has been shown that teams that have implemented routines and distributed responsibilities are more effective than those teams that have not [69,70]. Evidence for the important role team coordination plays comes from a meta-analysis of 93 studies undertaken by Stewart [71]. Stewart found that the level of intra-team coordination was positively related to team performance. The importance of team coordination appears to be even greater in dynamic situations [25] or in situations where multiple teams need to work together to achieve a common goal [72], as is often the case in EM.

2.1.3. Cooperation

Cooperation was the third element of teamwork identified by Wilson et al. [28]. This element encapsulates the shared attitudes and beliefs that enable team members to develop and hold compatible perceptions of the task and environment. These compatible perceptions help teams to improve their shared cognition, support more effective decision making, and enhance team performance. Wilson et al. suggested that cooperation positively influences team members' willingness and ability to communicate and coordinate with each other. Conversely, breakdowns in team cooperation occur when there is a lack of willingness to coordinate actions or ensure timely information flow [28].

Wilson et al. [28] identified four aspects of cooperation that support teamwork, namely: team orientation, collective efficacy, mutual trust, and team cohesion. Each of these aspects of cooperation support positive team member attitudes towards one another and the team's performance as a whole. For example: team orientation guides team members to put the collective needs of the team first; belief in collective efficacy of the team enables members to commit to the team and the tasks at hand; mutual trust supports sharing of information and makes it easier to provide or accept assistance; and team cohesion supports members to remain united in their pursuit of the team's objectives. Power [24] noted that there are some unique cooperation challenges in EM. These teams are often temporary and have a very fluid membership, meaning that members may be unfamiliar with one another. Closely linked to cooperation are issues of trust and competition. Research undertaken with emergency responders suggests that both issues of trust and competition can impede cooperation in teams [73].

Salas et al. [25] identify some further features of the relationship between aspects of cooperation and team performance. Higher levels of team efficacy enable teams to: apply more effort, engage in more strategic risk taking, perform better and have greater job satisfaction [74,75]. Higher levels of trust have a positive effect on organizational citizenship behaviors, organizational commitment, job satisfaction and team performance [76–81]. Higher levels of trust are also important in creating an environment that enables members to take interpersonal risks by speaking up, providing critical comments, and reporting errors or problems. This is described by Edmondson [82,83] as a team climate that is psychologically safe.

2.2. Behavioral markers and items for the checklist

One of the real strengths of Wilson et al. [28] and Salas et al.'s [25] taxonomy is the development of a set of behavioral markers that can be used to identify communication, coordination and cooperation in a simple and straight-forward manner in operational environments. Behavioral markers can be defined as 'statements that serve as indicators [f]or the presence or absence of the associated construct (e.g., coordination)' ([84], p. 114). From the perspective of building team effectiveness, behavioral markers can be used to assess and diagnose a team's strengths and weaknesses, and hence the team's particular developmental needs [85,86]. Wilson et al. [28] developed a set of 38 behavioral markers for team communication (10), coordination (13), and cooperation (15). For each of the aspects described earlier (e.g., information exchange, back up behavior, and team orientation) 3–4 behavioral markers are provided. These behavioral markers provide a simple practical way to examine teamwork in operational settings and formed the basic starting point for our development of the checklist to examine team processes (which we eventually called the team process checklist or TPC).

Focusing on communication, coordination and cooperation would appear to provide us with three central concepts of teamwork that can be easily and quickly observed in the field by a non-expert on teamwork. While we could undoubtedly have included more teamwork concepts, this would have led to a much more complex and lengthy tool, which would have defeated the main aim of the activity. We have therefore chosen to focus on a smaller core set of readily observable team processes to ensure that the checklist is highly useable for practitioners. This paper therefore aims to produce a prototype teamwork checklist based on the three elements of communication, coordination and cooperation that can be used both in real time and after the event. The next section outlines the development of the checklist.

3. Development of the TPC

The team process checklist (TPC) was developed in five regional coordination center (RCC) exercises conducted in Australia by one of our partner agencies who manage large-scale bushfires (wildfires). The regional level for this agency constitutes a multi-team system and provides a layer of coordination between the incident management teams and the state coordination team [87]. The regional level is responsible for identifying community risk, liaising with key stakeholders, allocating regional level resources and ensuring an

effective response to the emergency. For a list of typical tasks that a regional coordination center carries out see Hayes et al. [88].

The development team consisted of five experienced emergency managers (the users) from one of our partner agencies (mean age = 45 years, mean experience = 24.6 years; all male) and a senior university researcher (the first author). In the development team the users contributed their requirements, operational knowledge and understanding of the barriers to utilization and the university researcher contributed his knowledge of literature, theory and the research process [89]. In this respect the process used the philosophy of human centered design, where the intended user is placed at the center of the design process [90].

Each of the five exercises followed a similar format. The first part of the exercise began at 5pm on Day 1. In the first part of the exercise a briefing was provided to the regional duty officer about weather which represented high fire danger expected for the following day. The regional duty officer then explained the actions they would take to prepare. The second part of the exercise began at 8am on the following day. This involved a full activation of the RCC and constituted the main part of the exercise. As the exercise progressed a number of fires and other emergencies were reported which needed to be coordinated by the RCC. Throughout the exercise actors played the roles of people who would normally visit the center (such as police, media and senior agency officers) and simulated radio traffic on the fire ground. An example of an exercise is provided in the appendix.

The development team used the TPC to help them assess the teamwork of the RCC and to identify issues that needed to be addressed by the agency. The initial version of the TPC was developed based on the behavioral markers identified by Wilson et al. [28], supplemented by the work of Salas et al. [25] and Bearman et al. [1]. This consisted of an initial set of 38 items grouped into three categories: communication (10 items), coordination (13 items), and cooperation (15 items). The assessment of the RCC's performance was discussed with all staff at the end of each exercise and in a separate meeting with the regional commander. The research presented here focuses on the development of the TPC only and does not include the assessment of the RCC's teamwork made during the exercise.

At the end of each exercise between 3 and 5 members of the development team (including the university researcher) discussed the TPC in a small group meeting. The university researcher (the first author) and one of the users were present in all five meetings, one user was present in four meetings, one user was present in three meetings and two users were present at one meeting each. The number of users in the development team differed in each exercise because of the operational requirements of the agency which impacted on availability. The meeting was led by the first author and followed a similar format each time. The first author read out each item in the TPC and the users discussed their assessment of the RCC's performance. This allowed the development team to examine whether: 1) each item was valid and should be included in the checklist, 2) each item was clearly worded, 3) there was any overlap between items, 4) an item needed to be divided into two separate items, 5) each item referenced observable aspects of team performance, and 6) everyone had a common and consistent understanding of the concepts in the items. The TPC was revised by the first author based on these discussions and his own experience of using the checklist during the observations. After the first exercise a number of items were either removed or combined with other items so a revised version of the checklist was provided to the users before the second exercise. In the second exercise all of the items were considered to be valid by the users so this version of the checklist was used for the rest of the exercises. After the fifth exercise one item was combined with another item. The summary of the amendments made to the checklist based on these discussions is presented in Table 2.

At the end of the development process a final version of the TPC was produced that contained 17-items: communication (7 items), coordination (5 items), and cooperation (5 items). The final version of the TPC is in Table 3.

Inter-coder reliability was calculated for the agreement between the different users in each of the regional exercises. There were three users in Exercise 1, two users in Exercise 2, four users in Exercise 3, two users in Exercise 4 and three users in Exercise 5. One user was present at all five exercises, one user was present at four exercises, one user was present at three exercises and two users were present at one exercise each. Users coded items in the checklist as Yes, Somewhat, No or Not Observed. Not observed ratings were treated as missing data and were excluded from the analysis. For Exercise 1 Fleiss's Kappa was 0.243 indicating fair agreement. After this exercise the TPC was revised quite substantially, as described above. For Exercise 2 Cohen's Kappa was 0.879, for Exercise 4

Table 2
Amendments to the TPC made during the development phase.

Amendments
Three items that asked about closed loop communication and one item that referenced team members communicating clearly with others were combined into one item on team members ensuring that information had been received and understood by others.
One item on seeking information was removed because it was not clearly about communication.
An item on the completeness of communication was broadened to address the accuracy of communication.
An item on the collective motivation of the team and an ability to coordinate; an item on using input from other team members; and an item on the team remaining united in pursuit of mission goals were combined into one item about willingness to work as a team.
An item on compensating for others was removed because in practice it significantly overlapped with adjusting to meet the demands of the situation.
An item on team members exhibiting confidence in the team and an item on team members exhibiting trust in the team were combined into a single item on team members exhibiting confidence and trust in the team.
An item on resolving conflict was separated into two items: one on resolving differences of opinion and one asking whether anyone was creating unnecessary conflict.
Five items were reworded slightly to clarify, broaden, simplify, or shorten the item. For example, "Are team members providing 'big picture' situation updates was simplified, broadened, and shortened to "Are team members providing situation updates."
Three items were largely unchanged.

Table 3
Team process checklist.

Communication
Is information being passed on in a timely manner?
Is information being passed on accurately?
Are team members ensuring that information has been received and understood by others?
Are appropriate communication procedures being used?
Are situation updates being provided?
Coordination
Are the roles and responsibilities of team members clear?
Are actions always carried out as expected?
Do team members have a common understanding of information relating to the operation?
Is there a clear and common purpose?
Is everyone adjusting to meet the demands of the situation?
Are team members requesting assistance from others, where necessary?
Are team members correcting any mistakes made by others?
Cooperation
Does everyone show a willingness to work as a team?
Do team members exhibit confidence and trust in each other?
Is everyone following team objectives without opting for independence?
Are any differences of opinion being resolved effectively?
Is anyone creating unnecessary conflict?

Cohen's Kappa was 0.881 and for Exercise 5 Fleiss' Kappa was 0.869 indicating very high agreement. The level of agreement was not calculated for Exercise 3 because there was substantial missing data. The inter-coder reliability data indicates that after the checklist was revised following Exercise 1 the users were able to code the checklist items in a way that was highly consistent with other users.

After each item of the checklist had been discussed each user was asked whether they thought the TPC as a whole was useful and why/why not. These more global comments about the TPC could be categorized into a number of themes (see Table 4). The TPC was considered to cover a lot of topics, was useful as a self-assessment tool for debriefs and allowed people to step in to fix things in real time. As such it provided additional insight about teams to the users, although it was noted that it can be hard to change people's behaviors. The users also highlighted that the organization needs to clarify the expectations of team members so that a fair evaluation of the team can be made. The TPC could be used at different phases during an incident, particularly in the first 6 h where teams are often 'under the pump' and then after the first 6 h. Users highlighted that people need to be trained to use the TPC and that not everyone within an organization would have the right mindset to use it. Organizationally, the TPC could be used to supplement other assessments on processes and competencies. Users felt that the findings of the TPC were context specific but benchmarking could be done if the context is similar. After the first exercise it was felt that the TPC needed to be shorter and have better differentiation between the items, which was done for the second exercise and the users felt it had improved. These themes will be discussed further in the General Discussion section.

4. Evaluation studies

The next stage of the process is to evaluate the usefulness, clarity and comprehensiveness of the checklist. This section describes four quantitative evaluation studies that investigated these properties of the checklist using a wide range of people who work as emergency managers.

4.1. Study 1

4.1.1. Method
4.1.1.1. Design. Participants watched a video of a team performing a complex operational response and rated their performance using the TPC. Participants discussed the team's performance in small groups and then in a large group discussion. Following discussions of the team's performance participants individually evaluated the usefulness, clarity and comprehensiveness of the TPC as a tool to

Table 4
Themes from discussions about the TPC.

Theme	Statement
The TPC covers a lot of topics	"I think from a behavioral perspective it covered a lot of stuff."
The TPC is useful as a self-assessment tool	"To use it as a self-assessment tool to sit down and guide a bit of a debrief in terms of teams. I think it is useful."
The TPC allows people to step in and fix things in real time if they see something going wrong	"If we did real time performance then somebody could step in and say hey, it looks like you haven't got any missions or goals so I think there is a lack of role clarity here. How about we just stop for 5 and do this and this."
The TPC provides additional insight about teams	"I think it raised opportunities to look at some of the procedural operational components that feed into how behaviors are influenced."
Changing people's behaviors can be difficult	"It's hard to fix, it's hard to change people's behaviors."
Need to clarify what's expected of teams	"In measuring things like were the team able to perform as expected, some context around expected, given in this setting what is expected is somewhat unknown as opposed to other teams that we measure where what we measure is perhaps quite well known."
The TPC can be used in different phases of an incident	"What I would like as feedback for us to be able to grow and develop is to say tell us how we performed in the first half … How's our team working during the first 6 hours … Then we get our battle rhythm, we get our work rhythm, we get our reference for the second six."
People need to be trained in how to use the TPC	"For somebody to use it, like X or the other regional commanders we would need to provide a little bit of training."
Not everyone in an organization is going to use the TPC	"I think some people wouldn't have the mindset to even look at this."
The TPC can be used to supplement other assessment	"I think some of the things this picks up on would actually be useful to bring into the evaluation questions."
The findings are context specific	"You can't take this and use it as a benchmark across everything from that perspective because you've got to put it in context."
Benchmarking can be done if the context is similar.	"They are all working from the same baseline and I guess you can still look at it and go well in a particular region they didn't have an issue with purpose because they had a, they overcame the unknowns by making their own process … So I think you can still pull out some of that information for improvements even if you don't have the."
The TPC (used in the first exercise) needs to have more differentiation between the questions (which was done)	"Getting some greater differentiation between the questions, which is what we've talked about."
The TPC (used in the first exercise) needs to be shorter (which was done)	"By removing those questions it's something that's shorter."
The TPC improved after the first exercise	"I missed out on [Ex2] but it's improved from what we did in [Ex1] for sure. There's not as many questions that you ask … It works better."

evaluate teamwork. The data of interest here are the participants' ratings of the TPC.

4.1.1.2. Participants. 19 people with responsibility for EM in their agency took part in the study. There were seven females, nine males and three participants who didn't disclose their gender. The mean average age of participants was 48.9 and the mean average years of experience in EM was 18.6 (with three participants not declaring their age or years of experience). The participants attended the session as part of a National Australian Lessons Management Forum.

4.1.1.3. Materials. Participants watched a short video (4:27 min runtime) that depicted a stressful dynamic operational response to a situation. Participants were provided with a copy of the team process checklist (see Fig, 1) which they used to rate the performance of the team.

Participants provided their evaluation of the TPC on a questionnaire designed for the purpose. This questionnaire asked participants to: rate the usefulness overall of the TPC; rate the clarity of questions in the TPC; and rate the extent to which the TPC identified all of the good aspects and all the problems in teamwork that occurred (comprehensiveness). Participants provide their ratings on a 5-point scale, where the categories were identified as:

1. Useless
2. Limited
3. Good
4. Very Good
5. Excellent

Each number was further clarified with a description of what each category meant for usefulness, clarity and comprehensiveness. For example, a score of 5 for comprehensiveness was described as "Excellent" and "Identified all the important issues and some that I hadn't previously thought of."

4.1.1.4. Procedure. At the beginning of the session, participants were provided with a brief introduction to teamwork and the team process checklist so that they fully understood the teamwork concepts being considered. Participants were then provided with a copy

of the TPC and watched the video. Participants evaluated the performance of the team using the TPC in small groups (three groups of five and one group of four). The small groups had 30 mins to discuss the team's performance, which included watching the video a further two times. Then a large group discussion was held with all the participants about the team's performance, which lasted 20 mins. During this session recommendations on how to improve teamwork were made and recorded on a whiteboard. At the end of the large group discussion the questionnaire about the TPC was given to the participants and they completed their ratings individually. Once the questionnaires had been completed and returned participants were thanked and dismissed.

4.1.2. Results

Table 5 presents participants' mean ratings of the TPC in terms of usefulness, clarity and comprehensiveness. It can be seen that participants rated the overall usefulness of the TPC as 4.37 and the overall clarity of the questions as 4.58. The extent to which the TPC captured good aspects of teamwork was rated as 4.58 and the extent that it captured the problems in teamwork that occurred was rated as 4.33. All of these ratings were between the Very Good and Excellent categories. For usefulness a score of 4.00 was defined as "provides a very good understanding of teamwork," for clarity it was defined as "nearly all the questions were clear" and for comprehensiveness it was defined as "identified all the important issues."

4.2. Study 2

The results of Study 1 provide good evidence of the usefulness, clarity and comprehensiveness of the checklist. Study 2 was conducted to validate the results of Study 1 with a different group of participants and a slightly different method.

4.2.1. Method

4.2.1.1. Design, materials and procedure. The design, materials and procedure were the same as Study 1, with one exception. The small group discussion was not used in this study because of constraints of time. Participants rated the performance of the team individually using the TPC, then a large group discussion was held. As before, participants individually evaluated the usefulness, clarity and comprehensiveness of the TPC.

4.2.1.2. Participants. 15 people with responsibility for EM in their agency took part in the study. There were four females, nine males and two participants who didn't disclose their gender. The mean average age of participants was 42.2 and the mean average years of experience in EM was 19.3 (with two participants not declaring their age or years of experience). The participants attended the session as part of a National Research Advisory Forum run by the Bushfire & Natural Hazards Cooperative Research Centre.

4.2.2. Results

Table 5 presents participants' mean ratings of the TPC in terms of usefulness, clarity and comprehensiveness. It can be seen that participants rated the overall usefulness of the TPC as 3.93 and the overall clarity of the questions as 4.28. The extent to which the TPC captured good aspects of teamwork was rated as 3.80 and the extent that it captured the problems in teamwork that occurred was rated as 3.60. The usefulness of the TPC was therefore considered to be Very Good, the clarity between Excellent and Very Good and the comprehensiveness between Good and Very Good. As before, for usefulness a score of 4 was defined as "provides a very good understanding of teamwork," for clarity it was defined as "nearly all the questions were clear." A score of 3 for comprehensiveness was defined as "identified most of the important issues."

4.3. Study 3

In the previous two studies participants had a mean average age in the 40s (48.9 & 42.2) and had high average levels of experience in EM (18.6 & 19.3 years). Thus, a further study was conducted to validate the results of Study 1 and Study 2 with younger and less experienced participants.

4.3.1. Method

4.3.1.1. Design, materials and procedure. The design, materials and procedure were the same as Study 1, with the exception that in the small groups there were three groups of five participants and two groups of six.

4.3.1.2. Participants. 27 people with responsibility for EM in their agency took part in the study. There were eleven females, fifteen males and one participant who didn't disclose their gender. The mean average age of participants was 24 and the mean average years of experience in EM was 3.8 (with six participants not declaring their years of experience). The participants attended the session as part of a multi-agency Youth Advisory Council training session on incident management.

4.3.2. Results

Table 5 presents participants' mean ratings of the TPC in terms of usefulness, clarity and comprehensiveness. It can be seen that participants rated the overall usefulness of the TPC as 4.37 and the overall clarity of the questions as 4.30. The extent to which the TPC

Table 5

Mean evaluation ratings for usefulness, clarity, detection of good aspects of teamwork and detection of problems in teamwork (scored out of 5).

Criteria	Study 1	Study 2	Study 3	Study 4
Usefulness	4.37	3.93	4.37	4.00
Clarity	4.58	4.28	4.30	4.07
Good Aspects	4.58	3.80	4.00	4.09
Problems	4.33	3.60	4.31	4.09

captured good aspects of teamwork was rated as 4.00 and the extent that it captured the problems in teamwork that occurred was rated as 4.31. All of these ratings were between the Very Good and Excellent categories. As before, a score of 4 was defined as "provides a very good understanding of teamwork," for clarity it was defined as "nearly all the questions were clear" and for comprehensiveness it was defined as "identified all the important issues."

4.4. Study 4

The usefulness, clarity and comprehensiveness of the checklist in the three video-based studies conducted so far has been very good. To further establish the validity of the checklist an additional study was conducted with a very different focus. In this study the checklist was evaluated for use as an after-action review tool in a workshop held to evaluate an agency's response to a large-scale emergency.

4.4.1. Method

4.4.1.1. Design. Participants used the checklist to consider teamwork aspects of their agency's response to a large-scale flooding event in an after-action review workshop. Participants individually identified examples of good and bad teamwork using the checklist, then engaged in a large group discussion. Following discussions of team performance participants individually evaluated the usefulness, clarity and comprehensiveness of the TPC as a tool to evaluate teamwork. The data of interest here are the participants' ratings of the TPC.

4.4.1.2. Participants. 15 people with responsibility for EM in their agency took part in the study. There were 7 females and 8 males. The mean average age of participants was 43.6 and the mean average years of experience in EM was 16.5. The participants attended the session as part of an after-action review conducted by the agency they worked or volunteered for. Participants conducted the evaluation in work (or volunteer) time but were not otherwise paid.

4.4.1.3. Materials. The checklist and checklist evaluation form were the same as the ones used in Study 1.

4.4.1.4. Procedure. At the beginning of the session, participants were provided with a brief introduction to teamwork and the team process checklist so they understood the teamwork concepts being considered. Participants were then provided with a copy of the TPC and asked to individually provide examples of good and bad teamwork that occurred during the response on sticky notes (green for good and red for bad). Each of the teamwork categories from the TPC were printed on a piece of A4 size paper and stuck up on walls around the room. Participants were asked to place their examples of teamwork under the correct category. When all of the examples of teamwork had been stuck on the wall participants were asked to group the examples together into themes. Participants were able to move the examples as many times as they liked. The themes then formed the basis of a large group discussion about teamwork issues. In the large group discussion recommendations on how to improve teamwork were made and recorded on a whiteboard. At the end of the large group discussion the TPC evaluation questionnaire was given to the participants and they completed their ratings individually. Once the questionnaires had been completed and returned participants were thanked and dismissed.

4.4.2. Results

Table 5 presents participants ratings of the TPC in terms of usefulness, clarity and comprehensiveness. It can be seen that participants rated the overall usefulness of the TPC as 4.00 and the overall clarity of the questions as 4.07. The extent to which the TPC captured good aspects of teamwork was rated as 4.09 and the extent that it captured the problems in teamwork that occurred was also rated as 4.09. The usefulness, clarity and comprehensiveness of the TPC were therefore considered to be Very Good. As before, for usefulness a score of 4 was defined as "provides a very good understanding of teamwork," for clarity it was defined as "nearly all the questions were clear" and for comprehensiveness it was defined as "identified all the important issues."

4.5. Discussion of the evaluation studies

The Team Process Checklist (TPC) was evaluated in four separate studies. Three of these studies used a video of a team performing a complex task and the other used a post-hoc after-action review. Taken together these studies show that the usefulness, clarity and comprehensiveness of the TPC is around 4 out of 5, which is considered to be Very Good according to the definitions provided to participants. Further these studies demonstrate that the TPC is applicable to a wide range of people who work in emergency management and is a good way to assess both real time performance and after-action reviews.

5. General Discussion

This paper describes the development and evaluation of a prototype teamwork checklist (TPC) that is designed to help people to better understand and manage the processes of communication, coordination and cooperation in EM teams. The TPC is predominantly aimed at people working in multi-team system environments (such as incident management teams, regional coordination teams and state coordination teams) but is general enough that it could also be used with other kinds of teams (such as emergency responders). Communication, coordination and cooperation are foundational aspects of teamwork and the pillars on which other team functions, such as leadership, situation awareness and decision making depend [1,41,43,50,51]. An initial checklist was constructed based on the literature on communication, coordination and cooperation and then developed during five regional coordination center exercises conducted by one of our agency partners. These exercises allowed the development team to examine each item in the checklist. Based on the discussions a number of changes were made to the TPC to shorten it and provide better differentiation between the items. Following the development stage the TPC was evaluated by users in four studies and was found to have *very good* usefulness, clarity and comprehensiveness.

The TPC is designed to be used by people in emergency management to help them better understand and manage teamwork both in

real time and after the event. When used in real time it has two key applications. The first is as a health check, where a team leader or observer can check that the team is employing the behaviors that are expected of a high performing team. This is particularly useful to do when the team is under pressure from an emergency that is stretching their capability. The second application is to diagnose problems that are impacting a team's effectiveness. By working through the TPC problems can be diagnosed and solutions can be developed to help fix the problem. Sometimes these solutions can be fairly straight-forward, as stated by one of the development team users "If we did real time performance then somebody could step in and say hey, it looks like you haven't got any missions or goals so I think there is a lack of role clarity here. How about we just stop for 5 and do this and this." Sometimes a longer-term solution may need to be implemented, as might be required to deal with a person who is creating unnecessary conflict.

When used after the event in debriefs and after-action reviews the checklist can be used to better understand how the team performed in terms of information, actions and the situation. As one of the development team users pointed out, the TPC can be used effectively as a self-assessment tool to guide a team debrief and the fourth evaluation study showed that participants found the TPC to be useful when used in this context. One of the development team users pointed to the challenges of changing team member behavior. Provision of suitable feedback is central to changing people's behavior and the TPC provides specific feedback to people and teams based on behavioral markers. The provision of specific feedback has been found to be much more effective in changing people's behavior than normative feedback [91]. The findings from the debrief or after-action review using the TPC should also feed into the organization's lessons process where both short and long-term solutions to the problems identified can be implemented.

Similar to other complex activities such as aviation and surgery, EM can be broken down into the five phases of readiness, escalation, coordination, de-escalation and termination [88]. Unlike some checklists used in aviation and surgery that contain items tailored for specific phases of a flight or operation, the TPC can be used across the five phases of EM. The ability to use the TPC in different phases of the incident was noted by one of the development team users as a useful feature of the TPC. The user highlighted that this enabled evaluation of teamwork in the first part of a shift and then a second evaluation of teamwork later in the shift once the team had developed their battle and work rhythms.

The use of a checklist to manage teamwork (like the TPC) has benefits for all EM teams, but is particularly important in the multi-team system environments common at incident management and strategic levels of EM where there are multiple teams working to achieve separate but related objectives within a framework of overarching goals [4]. These EM environments pose a variety of teamwork related challenges, such as competing priorities and maintaining effective communication and coordination [9–12,14,15]. The TPC provides a simple tool to help people better understand and manage teamwork in multi-team system environments (such as the regional coordination centers examined in the Development section and incident management teams). The TPC could also be used to help Air Operations Managers, Divisional Commanders, Sector Commanders, and Strike Team Leaders monitor and review the teamwork of their units. Enhancing teamwork helps to improve the team's operational performance and reduces the friction and stress associated with working in demanding situations [92].

The development team users highlighted the need for training in how to use the TPC. This is also identified by Burian et al. [39] in the lifecycle framework as the fourth stage (induction, training and implementation). This is important in ensuring that the checklist is adopted and can be successfully used by teams and organizations. The crew resource management literature provides useful guidance on embedding the use of tools such as checklists into organizations. Flin et al. [85] advocate the use of a three phase approach enabling adoption through: awareness; practice and feedback; and the continual reinforcement loop. The first phase of awareness focuses on building users' understanding of the key concepts that underpin the teamwork content (3Cs) and the use of the checklist tool. In addition to the Team Process Checklist which outlines the tool's purpose and provides the 17 items, several short articles that explain the TPC have been published in EM agency magazines [93–95] and the Bushfire & Natural Hazards CRC *Hazard Note* series [96]. There are further Bushfire & Natural Hazards CRC published resources that can be used to help explain and provide training on the 3Cs including *A guide to non-technical skills in emergency management* [92] and two training packages on non-technical skills [97,98].

To help users gain practice and feedback in using the checklist a short video clip of a team performing a complex task can be used to help EM agencies train their personnel. Trainees would be asked to use the TPC to identify the good and poor team behaviors shown in the video clip. Subsequent discussions can then focus on why participants had identified particular teamwork behaviors as present or absent and the cues that helped them make these judgements. This also allows them to examine any observational discrepancies they may have with their peers. Instructors presenting these sessions could provide examples of the key behavioral cues that would likely be present in the EM teams within their organization to provide context for the participants. Providing clear examples of the types of behavioral cues helps to develop shared mental models for team members and may help them better understand what good teamwork and coordination really entails [99,100].

The facilitated discussion should also address rating issues of *observational accuracy* (i.e., correctly identifying the behaviors) and *rater accuracy* (i.e., assigning the correct rating) [85]. The use of the TPC in conjunction with a video provides behavioral observation training to help address observational and rater accuracy [101]. This material could be supplemented by discussion of observational errors such as ensuring observers remain focused on the actual behaviors, contamination from prior knowledge of the individuals or team being observed and over-reliance on a single example of a behavior [85]. Further issues that could be discussed are factors that undermine rater accuracy such as the influence of our own personal standards or preferences in what we think good or poor behavior looks like in the workplace [102,103] and biases such as halo, horns, primacy and recency.

The third phase of enabling adoption is the use of a continual reinforcement loop. This is usually led by organizations adopting new tools and skillsets and involves adopting ongoing refresher training and organizational practices such as workplace auditing, standard operating procedures, and learning and development systems. For example, the TPC can be embedded as part of exercises and training activities, and periodically discussions could be held with team leaders and managers on their use of the checklist. To help EM organizations improve their own ability to embed non-technical skills (such as communication, coordination and cooperation) into their

training and development programs the Australasian Fire and Emergency Services Authorities Council (AFAC) have published a *Guide to embedding non-technical skills into emergency management training* [104].

During the development of the TPC, we worked closely with users to co-create a checklist that is able to be used both in real time and after the event to examine EM teamwork. In this we drew on the philosophy of human-centered design, where the intended user is placed at the center of the design process [90]. In addition to harnessing the users' knowledge of their practical needs and context of use, placing them at the center of the design process means that a group of people within the agency can be created who have intimate knowledge of how the checklist works, including its intended and expected use [89]. This is important in helping to translate the research into practice as the new checklist is less likely to be seen as either alien or something handed down by management without consultation, thus helping to avoid resistance to its use (cf [105,106]). As the user group uses the checklist and supports others to use it widespread adoption is more likely to occur throughout the agency [89,107]. This acts to embed utilization and adoption as a central part of the research so that utilization and adoption are not something that are an after-thought following the completion of the research but something that is considered from the very beginning [89]. In the context of an increasing emphasis on engagement, impact and utilization in evaluating the quality of research outputs this is an important step forward.

The TPC has some limitations that should be pointed out. The TPC was designed to be used by both observers and team members in real time and after an event to evaluate teamwork in EM. This means that it needs to be brief, simple, easy to use and contain concepts that can be observed by someone who is not an expert on teamwork. To do this we focused on the three central processes of teamwork (communication, coordination and cooperation) and restricted the number of items to make the TPC short enough to use during an operation. This means that while the TPC can detect a range of issues it is unlikely to be able to detect everything that could go wrong in a team. Another potential problem with checklists such as the TPC is that different people may rate the same observed behavior in different ways. This is something that can be addressed in training in how to use the TPC, particularly if users are able to practice and receive feedback on their rating of teams observed in videos where a standard presentation is possible. The inter-rater reliability analysis from the development studies provides some level of confidence that users can rate observed behaviors in consistent ways using the TPC.

In conclusion, this paper describes the development and evaluation of a prototype teamwork checklist (TPC) that is designed to help people to better understand and manage the processes of communication, coordination and cooperation in EM teams both in real time and after the event. In real time the TPC can be used as either a health check to ensure the team is performing at a high level or as a way to diagnose problems in the team that need to be addressed. When used after the event for debriefs and after-action reviews the checklist can be used to better understand how the team performed in terms of information, actions and the situation. The TPC is designed to be simple, straight-forward and able to be used in the time-constrained environments typical in emergency management. Based on the research that we have conducted so far, the TPC appears to show much promise as a way to better understand and manage teamwork in emergency management.

Acknowledgements

Appendix

Example of an Exercise

Seasonal Outlook

There has been a late start to the fire season with significant periods of rain running through into late November. A late burst of hot weather in December with moist soils has promoted additional grass growth which has now cured off, resulting in grass growth through the district at above average levels. Resulting grass fuel loads are higher than average.

Day 1

At 1630 the Bureau of Meteorology issued Total Fire Bans for the entire state for the following day. The fire ban districts of A and B have been declared Extreme with weather conditions expected as.

Temperature 38° C

Winds Northerly at 35 km/h gusting to 40 km/h.

Relative Humidity 15%

Fire Danger rating of 75 grass

Day 2

The Actual Weather on Day 2 is as follows:

Temperature 32° C

Winds Northerly 35 km/h gusts to 45 km/h.

At 09:15 Brigade X and Brigade Y have responded to the report of a grass fire resulting from a grain harvester fire, 20 km north of W township. The initial situation report from Brigade X is as follows:

"Brigade X confirms grass fire and harvester fire at Z location. Harvester is completely destroyed. The grass fire is fast moving in a southerly direction. The fire is progressing towards hilly terrain and heading for W township. We are unable to attack the front of the fire due to speed of the front. Request additional assistance and bombing aircraft."

The forward rate of spread (FROS) of the grass fire is 4.5km/h in grass/crop. Rapid fire spread in grassland continues to hamper direct attack efforts. The wind initially drives the fire in a southerly direction and it will impact on W township if the fire spread in the hills is unable to be contained. As the fire impacts on the hilly terrain the rate of spread of the fire increases with some spotting occurring.

At some point during the day a structure fire is reported in the township of A. The initial report from the first arriving brigade indicated the house was well alight with flames showing through the roof. The Incident Controller requested 4 additional brigades to respond, together with power utilities, police, ambulance and fire investigation. No residents were reported injured and the house's occupants were not home at the time of the fire. The fire was also reported to be threatening adjoining structures.

The Regional Command Center is to manage the incidents as if they were actually occurring. Standard Operating Procedures are to be followed. This includes appropriate communications to State Command Center, other emergency services, public warning messaging, etc.

References

[1] C. Bearman, J. Grunwald, B. Brooks, C. Owen, Breakdowns in coordinated decision making at and above the incident management team level: an analysis of three large scale Australian wildfires, Appl. Ergon. 47 (2015) 16–25, https://doi.org/10.1016/j.apergo.2014.08.009.

[2] K. James, The organization of disaster/teriorism prevention and response: theory building toward the future of the field, J. Organ. Behav. 32 (2011) 1013–1032, https://doi.org/10.1002/job.782.

[3] D. Paton, C. Owen, Incident management, in: K.B. Penuel, M. Statler, R. Hagen (Eds.), Encyclopedia of Crisis Management, Sage, 2013, pp. 503–506.

[4] O. Brown, N. Power, S.M. Conchie, Communication and coordination across event phases: a multi-team system emergency response, J. Occup. Organ. Psychol. 94 (3) (2021) 591–615, https://doi.org/10.1111/joop.12349.

[5] J.E. Mathieu, M.A. Marks, S.J. Zaccaro, Multi-team systems, in: N. Anderson, D. Ones, K. Sinangil, C. Viswesvaran (Eds.), Handbook of Industrial, Work and Organizational Psychology, vol. 2, Sage, 2001, pp. 289–313.

[6] M.L. Shuffler, M. Jiménez-Rodríguez, W.S. Kramer, The science of multiteam systems: a review and future research agenda, Small Group Res. 46 (6) (2015) 659–699, https://doi.org/10.1177/1046496415603455.

[7] M.A. Marks, L.A. Dechurch, J.E. Mathieu, F.J. Panzer, A. Alonso, Teamwork in multiteam systems, J. Appl. Psychol. 90 (5) (2005) 964–971, https://doi.org/10.1037/0021-9010.90.5.964.

[8] S.J. Zaccaro, M.A. Marks, L. DeChurch, Multiteam Systems : an Organization Form for Dynamic and Complex Environments, 1 ed., Taylor & Francis, 2011.

[9] F.N. Abdeen, T. Fernando, U. Kulatunga, S. Hettige, K.D.A. Ranasinghe, Challenges in multi-agency collaboration in disaster management: a Sri Lankan perspective, Int. J. Disaster Risk Reduc. 62 (2021), 102399, https://doi.org/10.1016/j.ijdrr.2021.102399.

[10] O.C. Fodor, A.M. Flestea, When fluid structures fail, Team Perform. Manag. 22 (3/4) (2016) 156–180, https://doi.org/10.1108/TPM-11-2015-0055.

[11] R. Kerslake, H. Deeming, A. Goodwin, K. Lund, M. Wahlstrom, The Kerslake Report: an Independent Review into the Preparedness for, and Emergency Response to, the Manchester Arena Attack on 22nd May 2017, 2018. https://kerslakearenareview.co.uk/media/1022/kerslake_arena_review_printed_final.pdf.

[12] R. McMaster, C. Baber, Multi-agency operations: cooperation during flooding, Appl. Ergon. 43 (1) (2012) 38–47, https://doi.org/10.1016/j.apergo.2011.03.006.

[13] C. Owen, C. Bearman, B. Brooks, J. Chapman, D. Paton, L. Hossain, Developing a research framework for complex multi-team coordination in emergency management, Int. J. Emerg. Manag. 9 (1) (2013) 1–17.

[14] K. Pollock, Local interoperability in UK emergency management: a research report, Emergency Planning College (2017). https://www.researchgate.net/deref/https%3A%2F%2Fwww.researchgate.net%2Fpublication%2F336719370_Local_Interoperability_in_UK_Emergency_Management_A_Research_Report_Commissioned_by_the_Cabinet_Office_and_the_Emergency_Planning_College?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19.

[15] S. Waring, L. Alison, N. Shortland, M. Humann, The role of information sharing on decision delay during multiteam disaster response, Cognit. Technol. Work 22 (2) (2020) 263–279, https://doi.org/10.1007/s10111-019-00570-7.

[16] S. Waring, J.-L. Moran, R. Page, Decision-making in multiagency multiteam systems operating in extreme environments, J. Occup. Organ. Psychol. 93 (3) (2020), e12309, https://doi.org/10.1111/joop.12309.

[17] L. Alison, N. Power, C. van den Heuvel, M. Humann, M. Palasinksi, J. Crego, Decision inertia: deciding between least worst outcomes in emergency responses to disasters, J. Occup. Organ. Psychol. 88 (2) (2015) 295–321, https://doi.org/10.1111/joop.12108.

[18] R. Chen, R. Sharman, H.R. Rao, S.J. Upadhyaya, Coordination in emergency response management, Commun. ACM 51 (5) (2008) 66–73, https://doi.org/10.1145/1342327.1342340.

[19] P. Salmon, N. Stanton, D. Jenkins, G. Walker, Coordination during multi-agency emergency response: issues and solutions, Disaster Prev. Manag. 20 (2) (2011) 140–158, https://doi.org/10.1108/09653561111126085.

[20] L.A. DeChurch, J.E. Mathieu, Thinking in terms of multiteam systems, in: E. Salas, A. Goodwin, C.S. Burke (Eds.), Team Effectiveness in Complex Organizations: Cross Disciplinary Perspectives and Approaches, Taylor & Francis, 2009, pp. 267–292.

[21] M.M. Luciano, L.A. DeChurch, J.E. Mathieu, Multiteam systems: a structural framework and meso-theory of system functioning, J. Manag. 44 (3) (2018) 1065–1096, https://doi.org/10.1177/0149206315601184.

[22] C. Bearman, S. Rainbird, B. Brooks, C. Owen, S. Curnin, A literature review of methods for providing enhanced operational oversight of teams in emergency management, Int. J. Emerg. Manag. 14 (3) (2018) 254–274, https://doi.org/10.1504/IJEM.2018.094237.

[23] E. Salas, C.S. Burke, S.N. Samman, Understanding command and control teams operating in complex environments, Inf. Knowl. Syst. Manag. 2 (2001) 311–323.

[24] N. Power, Extreme teams: towards a greater understanding of multiagency teamwork during major emergencies and disasters, Am. Psychol. 73 (4) (2018) 478–490, https://doi.org/10.1037/amp0000248.

[25] E. Salas, M. Shuffler, A.L. Thayer, W.L. Bedwell, E.H. Lazzara, Understanding and improving teamwork in organizations: a scientifically based practical guide, Hum. Resour. Manag. 54 (4) (2015) 599–622, https://doi.org/10.1002/hrm.21628.

[26] S.J. Weaver, X.X. Che, P.J. Pronovost, C.A. Goeschel, K.C. Kosel, M.A. Rosen, Improving patient safety and care quality: a multiteam system perspective, in: Pushing the boundaries: Multiteam systems in research and practice 16, Emerald Group, 2014, pp. 35–60.

[27] L.B. Landon, W.B. Vessey, J.D. Barrett, Evidence Report: Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team, NASA, 2016.

[28] K.A. Wilson, E. Salas, H.A. Priest, D. Andrews, Errors in the heat of battle: taking a closer look at shared cognition breakdowns through teamwork, Hum. Factors 49 (2) (2007) 243–256, https://doi.org/10.1518/001872007X312478.

[29] H. de Bruijn, One fight, one team: the 9/11 Commission report on Intelligence, fragmentation and informtion, Publ. Adm. 84 (2) (2006) 267–287, https://doi.org/10.1111/j.1467-9299.2006.00002.x.

[30] A.M. Olejarski, J.L. Garnett, Coping with Katrina: assessing crisis management behaviours in the big one, J. Contingencies Crisis Manag. 18 (1) (2010) 26–38, https://doi.org/10.1111/j.1468-5973.2009.00597.x.

[31] C. Cooper, R. Block, Disaster: Hurricane Katrina and the Failure of Homeland Security, Times Books, 2006.

[32] J.L. Garnett, A. Kouzmin, Communicating throughout Katrina: competing and complementary conceptual lenses on crisis communication, Publ. Adm. Rev. 67 (s1) (2007) 177–188, https://doi.org/10.1111/j.1540-6210.2007.00826.x.

[33] K. Pollock, Review of Persistent Lessons Relating to Interoperability from Emergencies and Major Incidents since 1986 (Occasional Paper No. 6), Emergency Planning College, 2013.

[34] AFAC, The Australasian Inter-service Incident Management System (AIIMS2017), Australasian Fire and Emergency Services Authorities Council, 2017.

[35] A. Chaparro, J.R. Keebler, E.H. Lazzara, A. Diamond, Checklists: a review of their origins, benefits, and current uses as a cognitive aid in medicine, Ergon. Des 27 (2019) 21–26, https://doi.org/10.1177/1064804618819181.

[36] A.C. McLaughlin, V.E. Byrne, A fundamental cognitive taxonomy for cognition aids, Hum. Factors 62 (6) (2020) 865–873, https://doi.org/10.1177/0018720820920099.

[37] V.E. Lyons, L.L. Popejoy, Meta-analysis of surgical safety checklist effects on teamwork, communication, morbidity, mortality, and safety, West. J. Nurs. Res. 36 (2) (2014) 245–261, https://doi.org/10.1177/0193945913505782.

[38] J. Paoletti, T.M. Bisbey, D.L. Reyes, M.A. Wettergreen, E. Salas, A checklist to diagnose teamwork in engineering education, Int. J. Eng. Educ. 36 (B) (2020) 365–377.

[39] B. Burian, A. Clebone, K. Dismukes, K. Ruskin, More than a tick box: medical checklist development, design, and use, Anesth. Analg. 126 (1) (2018) 223–232, https://doi.org/10.1213/ANE.0000000000002286.

[40] A. Gawande, The Checklist Manifesto: How to Get Things Right, Picador, 2010.

[41] P. Hayes, C. Bearman, P.C. Butler, C. Owen, Non-technical skills for emergency incident management teams: a literature review, J. Contingencies Crisis Manag. 29 (2) (2021) 185–203, https://doi.org/10.1111/1468-5973.12341.

[42] S.W.J. Kozlowski, B.S. Bell, Work groups and teams in organizations, in: W.C. Borman, D.R. Ilgen, R.J. Klimoski (Eds.), Handbook of Psychology: Volume 12 Industrial and Organizational Psychology, Wiley, 2003, pp. 333–375.

[43] L.A. Rafferty, N.A. Stanton, G.H. Walker, The famous five factors in teamwork: a case study of fratricide, Ergonomics 53 (10) (2010) 1187–1204, https://doi.org/10.1016/j.ssci.2012.03.020.

[44] T.H.L. Cullen, The Public Inquiry into the Piper Alpha Disaster, Vols I and II (CM1310), HMSO, 1990.

[45] S. Ellis, The aftermath of the Christchurch earthquakes, 2011, in: S. Ellis, K. MacCarter (Eds.), Incident Management in Australasia, CSIRO, 2016, pp. 61–81.

[46] Y. Funabashi, K. Kitazawa, Fukushima in review: a complex disaster, a disastrous response, Bull. At. Sci. 68 (2) (2012) 9–21, https://doi.org/10.1177/0096340212440359.

[47] G. Johnstone, Report of the Investigation and Inquests onto Wildfire and the Deaths of Five Volunteers at Linton on 2 December 1998, State Coroner's Office Victoria, 2002.

[48] National Oil Spill Commission, Deep Water: the Gulf of Mexico oil disaster and the future of offshore drilling, National Commission on the BP Deep Water Horizon Oil Spill and Offshore Drilling (2011).

[49] D.P. Moynihan, The network governance of crisis response: case studies of incident command systems, J. Publ. Adm. Res. Theor. 19 (4) (2009) 895–915, https://doi.org/10.1093/jopart/mun033.

[50] H. Fuks, A. Raposo, M.A. Gerosa, M. Pimentel, D. Filippo, C. Lucena, Inter- and Intra-relationships between Communication Coordination and Cooperation in the Scope of the 3C Collaboration Model 12th International Conference on Computer Supported Cooperative Work in Design, Xi'an, 2008.

[51] V.P. Crawford, Experiments on cognition, communication, coordination, and cooperation in relationships, Annual Review of Economics 11 (1) (2019) 167–191, https://doi.org/10.1146/annurev-economics-080218-025730.

[52] A.B. Badiru, L. Racz, Coordinated project systems approach to emergency response, in: A.B. Badiru, L. Racz (Eds.), Handbook of Emergency Response: A Human Factors and Systems Engineering Approach, CRC Press, 2017, pp. 413–438.

[53] R.M. McIntyre, E. Salas, Measuring and managing for team performance: emerging principles from complex environments, in: R. Guzzo, E. Salas (Eds.), Team Effectiveness and Decision Making in Organizations, Jossey-Bass, 1995, pp. 9–45.

[54] T.L. Sellnow, M.W. Seegar, Theorizing Crisis Communication, Wiley-Blackwell, 2013.

[55] D.K. Berlo, The Process of Communication: an Introduction to Theory and Practice, Holt, Rinehart, and Winston, 1960.

[56] D.C. Barnlund, A transactional model of communication, in: C.D. Mortensen (Ed.), Communication Theory, 2 ed., Routledge, 2008, pp. 47–57.

[57] F.E.X. Dance, C. Larson, The Functions of Human Communication: A Theoretical Approach, Holt, Rinehart, and Winston, 1976.

[58] J.R. Mesmer-Magnus, L.A. DeChurch, Information sharing and team performance: a meta-analysis, J. Appl. Psychol. 94 (2009) 535–546, https://doi.org/10.1037/a0013773.

[59] P. Hayes, M.M. Omodei, Managing emergencies: key competencies for incident management teams, Aust. N. Z. J. Organ. Psychol. 4 (2011) 1–10, https://doi.org/10.1375/ajop.4.1.1.

[60] K.A. Smith-Jentsch, R.L. Zeisig, B. Acton, J.A. McPherson, Team dimensional training: a strategy for guided team self-correction, in: J.A. Cannon-Bowers, E. Salas (Eds.), Making Decisions under Stress: Implications for Individual and Team Training, American Psychological Association, 1998, pp. 271–297.

[61] C.A. Bowers, F. Jentsch, E. Salas, C.C. Braun, Analyzing communication sequences for team training needs assessment, Hum. Factors 40 (4) (1998) 672–679, https://doi.org/10.1518/001872098779649265.

[62] J. MacMillan, E.E. Entin, D. Serfaty, Communication overhead: the hidden cost of team cognition, in: E. Salas, S.M. Fiore (Eds.), Team Cognition: Understanding the Factors that Drive Process and Performance, American Psychological Association, 2004, pp. 61–82.

[63] M.A. Marks, J.E. Mathieu, S.J. Zaccaro, A temporally based framework and taxonomy of team processes, Acad. Manag. Rev. 26 (2001) 356–376, https://doi.org/10.5465/amr.2001.4845785.

[64] E. Salas, D.E. Sims, C.S. Burke, Is there a "big five" in teamwork? Small Group Res. 36 (2005) 555–599, https://doi.org/10.1177/1046496405277134.

[65] Y. Xiao, J. Moss, Practices of High Reliability Teams: Observations in Trauma Resuscitation, 45th Annual Meeting of the Human Factors and Ergonomics Society, Minneapolis, MN, 2001.

[66] V. Rousseau, C. Aubé, A. Savoie, Teamwork behaviors: a review and an integration of frameworks, Small Group Res. 37 (2006) 540–570, https://doi.org/10.1177/1046496406293125.

[67] S.J. Guastello, D.D. Guastello, Origins of coordination and team effectiveness: a perspective from game theory and nonlinear dynamics, J. Appl. Psychol. 83 (3) (1998) 423–437, https://doi.org/10.1037/0021-9010.83.3.423.

[68] J.A. Espinosa, F.J. Lerch, R.E. Kraut, Explicit versus implicit coordination mechanisms and task dependencies: one size does not fit all, in: E. Salas, S.M. Fiore (Eds.), Team Cognition: Understanding the Factors that Drive Process and Performance, American Psychological Association, 2004, pp. 107–129.

[69] C.J.G. Gersick, Time and transition in work teams: toward a new model of group development, Acad. Manag. J. 31 (1988) 9–41, https://doi.org/10.5465/256496.

[70] K.E. Weick, K.H. Roberts, Collective mind in an organizations: heedful interrelating on flight decks, Adm. Sci. Q. 38 (1993) 357–381, https://doi.org/10.2307/2393372.

[71] G.L. Stewart, A meta-analytic review of relationships between team design features and team performance, J. Manag. 32 (2006) 29–54, https://doi.org/10.1177/0149206305277792.

[72] J.E. Mathieu, T. Maynard, T. Rapp, L. Gilson, Team effectiveness 1997-2007: a review of recent advancements and a glimpse into the future, J. Manag. 34 (2008) 410–476, https://doi.org/10.1177/0149206308316061.

[73] N. Power, L. Alison, Redundant deliberation about negative consequences: decision inertia in emergency responders, Psychol. Publ. Pol. Law 23 (2017) 243–258, https://doi.org/10.1037/law0000114.

[74] D. Knight, C.C. Durham, E.A. Locke, The relationship of team goals, incentives, and efficacy to strategic risk, tactical implementation, and performance, Acad. Manag. J. 44 (2) (2001) 326–338, https://doi.org/10.2307/3069459.

[75] S.W. Lester, B.M. Meglino, M.A. Korsgaard, The antecedents and consequences of group potency: a longitudinal investigation of newly formed work groups, Acad. Manag. J. 45 (2) (2002) 352–368, https://doi.org/10.2307/3069351.

[76] J.A. Colquitt, B.A. Scott, J.A. LePine, Trust, trustworthiness, and trust propensity: a meta-analytic test of their unique relationships with risk taking and job performance, J. Appl. Psychol. 92 (2007) 909–927, https://doi.org/10.1037/0021-9010.92.4.909.

[77] A.C. Costa, Work team trust and effectiveness, Person. Rev. 32 (2003) 605–622, https://doi.org/10.1108/00483480310488360.

[78] K.T. Dirks, D.L. Ferrin, Trust in leadership: meta-analytic findings and implications for research and practice, J. Appl. Psychol. 87 (2002) 611–628, https://doi.org/10.1037/0021-9010.87.4.611.

[79] B.L. Kirkman, B. Rosen, P.E. Tesluk, C.B. Gibson, Enhancing the transfer of computer-assisted training proficiency in geographically distributed teams, J. Appl. Psychol. 91 (2006) 706–716, https://doi.org/10.1037/0021-9010.91.3.706.

[80] C.W. Langfred, The downside of self-management: a longitudinal study of the effects of conflict on trust, autonomy, and task Interdependence in self-managing teams, Acad. Manag. J. 50 (4) (2007) 885–900, https://doi.org/10.2307/20159895.

[81] S.S. Webber, Development of cognitive and affective trust in teams: a longitudinal study, Small Group Res. 39 (2008) 746–769, https://doi.org/10.1177/1046496408323569.

[82] A. Edmondson, Psychological safety and learning behavior in work teams, Adm. Sci. Q. 44 (1999) 350–383, https://doi.org/10.2307/2666999.

[83] A. Edmondson, Managing the risk of learning: psychological safety in work teams, in: M.A. West, D. Tjosvold, K.G. Smith (Eds.), International Handbook of Organizational Teamwork and Cooperative Working, Blackwell, 2003.

[84] M.A. Rosen, W.L. Bedwell, J.L. Wildman, B.A. Fritzsche, E. Salas, C.S. Burke, Managing adaptive performance in teams: guiding principles and behavioral markers for measurement, Hum. Resour. Manag. Rev. 21 (2) (2011) 107–122, https://doi.org/10.1016/j.hrmr.2010.09.003.

[85] R. Flin, P. O'Connor, M. Crichton, Safety at the Sharp End: A Guide to Non-technical Skills, Ashgate, 2008.

[86] A. Lantz, D. Ulber, P. Friedrich, The Problems with Teamwork, and How to Solve Them, Routledge, 2020.

[87] J. Grunwald, C. Bearman, Identifying and resolving coordinated decision making breakdowns in emergency management, Int. J. Emerg. Manag. 13 (1) (2017) 68–86, https://doi.org/10.1504/IJEM.2017.081198.

[88] P. Hayes, C. Bearman, M. Thomason, P. Bremner, Staying on task: a tool to help state and regional-level emergency management teams, Aust. J. Emerg. Manag. 35 (1) (2020) 38–44, https://doi.org/10.3316/agispt.20200303026424.

[89] C. Bearman, B. Brooks, C. Owen, S. Curnin, Using the human centred design method for non-technical skills in emergency management, in: Bushfire and Natural Hazards CRC Report No.532, Bushfire & Natural Hazards CRC, 2018.

[90] ISO, ISO 9241-210:2010 Ergonomics of Human-System Interaction (Part 210: Human-Centred Design for Interactive Systems), International Organization for Standardization, 2010.

[91] A.N. Kluger, A.S. DeNisi, The effects of feedback interventions on performance: a historical review, meta-analysis, and a preliminary feedback intervention theory, Psychol. Bull. 119 (1996) 254–284.

[92] P. Hayes, C. Bearman, D. Gyles, A Guide to Non-technical Skills in Emergency Management, Bushfire & Natural Hazard CRC, 2022.

[93] C. Bearman, Improving teamwork, Brigade 37 (2017) 14.

[94] C. Bearman, M. Thomason, Teamwork checklists, in: CFS 2017 Volunteer Yearbook, South Australian Country Fire Service, 2017.

[95] C. Haritos, Teamwork when the heat is on, Fire Australia 2 (2018) 24–25.

[96] C. Bearman, S. Rainbird, C. Owen, B. Brooks, Tools to enhance emergency management team performance, Hazard Note (33) (2017) 1–4.

[97] P. Hayes, C. Bearman, D. Gyles, Emergency Management Non-technical Skills: Advanced Workshop, Bushfire & Natural Hazard CRC, 2022.

[98] P. Hayes, C. Bearman, D. Gyles, Emergency Management Non-technical Skills: Key Concepts, Bushfire & Natural Hazard CRC, 2022.

[99] J.A. Cannon-Bowers, E. Salas, S.A. Converse, Shared mental models in expert team decision making, in: N.J. Castellan (Ed.), Individual and Group Decision Making, Lawrence Erlbaum, 1993, pp. 221–246.

[100] A.M. Schaafstal, J.H. Johnston, R.L. Oser, Training teams for emergency management, Comput. Hum. Behav. 17 (5) (2001) 615–626, https://doi.org/10.1016/S0747-5632(01)00026-7.

[101] D.P. Baker, C. Mulqueen, R.K. Dismukes, Training raters to assess resource management skills, in: E. Salas, C.A. Bowers, E. Edens (Eds.), Improving Teamwork in Organizations: Applications of Resource Management Training, Lawrence Erlbaum, 2001, pp. 131–145.

[102] W.C. Borman, Personal constructs, performance schemata, and "folk theories" of subordinate effectiveness: explorations in an army officer sample, Organ. Behav. Hum. Decis. Process. 40 (3) (1987) 307–322, https://doi.org/10.1016/0749-5978(87)90018-5.

[103] N. MacLeod, Building Safe Systems in Aviation: A CRM Developer's Handbook, Ashgate, 2005.

[104] P. Hayes, C. Bearman, Guide to Embedding Non-technical Skills in Emergency Management Training, Australasian Fire and Emergency Services Authorities Council, 2023.

[105] P. Prasad, A. Prasad, Stretching the iron cage: the constitution and implications of routine workplace resistance, Organ. Sci. 11 (4) (2000) 387–403, https://doi.org/10.1287/orsc.11.4.387.14597.

[106] J.A. Rose, C. Bearman, Resistance to technology, in: C. Bearman, A. Naweed, J. Dorrian, J.A. Rose, D. Dawson (Eds.), Evaluation of Rail Technology: A Practical Human Factors Guide, Ashgate, 2013, pp. 23–54.

[107] D. Leonard-Barton, W.A. Kraus, Implementing new technology, Harv. Bus. Rev. 63 (6) (1985) 102–110.