

# INFORMATION SYSTEMS IMPLICATIONS FOR INFORMATION FLOW BETWEEN LAYERS IN EMERGENCY MANAGEMENT COORDINATION

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## Executive summary

This report addresses the first of three information systems deliverables contained within the research project *Organising for Effective Incident Management*. The focus here is on better understanding the work performed at regional and state levels of incident so that the implications for information systems supporting that work can be addressed. The report commences with a framework for understanding work activity in complex socio-technical domains and then conducts an analysis of the kinds of decisions made and challenges faced at state and regional levels. It then outlines a number of implications that information systems would need to address in order to support the work that people undertake in those state and regional roles.

Two organisational surveys were used as the main sources of data collection. In the first organisational survey 206 experienced personnel across a range of jurisdictions and states in Australia and New Zealand provided an outline of their activities and challenges in their main roles at a recent incident. This yielded comments from participants working at state/national levels (n=30); regional levels (n=49) and local levels (n=58) of incident management. For the purposes of this report the 79 participants working at regional and state/national levels made 120 comments and these have been included in the data analysis.

A second organisational survey, undertaken by the Office for the Fire Services Commissioner in Victoria, was also used because it provides a more detailed case study of the information needs of the various stakeholders involved at state and regional levels in one multi-jurisdictional location. The data reported here is a recoding and re-analysis of components of that survey. Victorian participants were asked to nominate the role they most commonly perform in an incident and to list the three most important decisions/actions they make in that role. Only personnel who were engaged in work at a state or regional level were included in this analysis (state n=80; regional n=23) and they yielded 160 comments.

The comments from the two organisational surveys were analysed and grouped into five themes, each with sub-themes.

*Problem detection and situation assessment.* Activities associated with problem detection included the sub-themes of situation assessment and risk assessment. The challenges for information flow between emergency management layers include establishing effective communication and accountability flows between the various layers so that there was clarity around resource allocation and communication infrastructures. This was particularly important for those in urban fire services and for personnel operating at a regional level. Gaining sufficient information for a full assessment of the situation was made difficult by multiple and escalating individual

incidents and the need to consider multiple stakeholder needs. Information systems implications include the need to represent transitions in incident escalation as well as to develop indicators that may be used for early detection of situation anomalies that may need closer monitoring and attention to mitigate system degradation.

*Task execution and resource management.* The second theme identified included activities associated with supporting the execution of tasks, which involved considerable resource management. Two sub-themes identified included managing competing priorities and managing resources. In large events, interstate and international deployments are needed and different policies and procedures need to be negotiated. Challenges for information flow within emergency management layers relate to the need for clarity and transparency on resource tasking, closing request/action loops and managing with insufficient resources. Prioritisation of resource requests is also a challenge.

*Prediction and planning for future states.* The third theme involved activities associated with anticipation and prediction and included three sub-themes: gaining and maintaining situation awareness; determining likely future impacts and developing strategic plans. Challenges to information flow between emergency management layers included incomplete and inconsistent information as well as the ability to access related information for consequence management (e.g., location sites for future evacuations) and managing goal and priority conflicts. Information systems implications include the need for feed-forward modelling and networked distribution points for information flow between related stakeholders.

*Sense-making and the development of strategy.* The fourth theme related to activities associated with sense-making and the development of broader emergency management strategy. Challenges faced at state and regional levels included managing competing government and political interests as well as ensuring consistent messaging to affected communities. Providing meaning to different stakeholder groups was of particular concern. Information systems implications include the need for shared databases and for streamlining processes for emergency alerts to communities so that they can be timely. Boundary spanning roles were critical as were other mechanisms to bridge different positions, intentions, needs and interests, including aligning strategic goals with existing government policy goals. Providing updates and meaning with situational advice for stakeholder groups was reported as particularly important.

*Evaluation and quality assurance.* The final theme was focussed on evaluation and assuring the quality of the incident management processes in place. Activities associated with monitoring the safety health of the incident management system were discussed. The challenges for information flow between layers in the emergency management framework include overcoming incomplete information and the withholding of information by different stakeholder groups. Implications for

information systems include tracking processes designed to provide a snapshot of the status of various activities and any pressure points within the system. An additional survey question in the national survey revealed that most personnel working at regional and state levels do not have a fully articulated practice of how continuous ongoing evaluation occurs at these levels.

It will be important in the next phase of this research work to examine the types of information systems modalities personnel use to support these activities and to consult with industry personnel about whether they believe the mix of activity is appropriate for differing levels of emergency management.

The next phase of the research will examine the existing information systems and the interfaces used to support regional and state level activities and will discuss the principles that future information systems would need to address with industry stakeholders.

## Overall scope and this report

This report forms part of the Bushfire CRC Research Project *Organising for Effective Incident Management* investigating emergency management activity above the local Incident Management Team (IMT) level. The purpose and scope of the existing research project is to measure, map and model multi-agency emergency management coordination above the Incident Management Team level and to identify ways in which it can be improved to reduce the consequences to communities of the emergency event.

The deliverables covering the three phases of this *information systems* component of the project are:

1. Information systems implications for information flow between layers in emergency management coordination
2. Summary of human–technology interface implications provided to lead end user for feedback and comment
3. Summary of human–technology interface implications completed.

This report addresses the first component by establishing a framework for analysis of the activity occurring above the IMT level and then discusses findings from survey data where experienced personnel described the kinds of activities they were engaged in at regional and state levels of coordination, their challenges and the decisions/actions they were required to undertake.

From this perspective then it should be noted that this is not a report about information systems technologies, as these will change quickly over time. Rather, this report scopes out the work performed at regional and state levels of incident management and the information-related demands of those personnel. In part this is because this area is under-researched and as yet unmapped. The report then discusses the implications for systems to support those work activities.

The next phase of the research will consult industry stakeholders about their perceptions of the information flow demands between layers in the emergency management system to develop principles that information systems interfaces would need to address to support the work undertaken.

## Background

The emergency services industry has typically been a paper-based “belts and braces” industry although the increase of technological application has been fast and

pervasive. Ten years ago the industry would have been mostly relying on the use of radio and developing incident action plans in paper form with most coordination occurring in face-to-face meetings. Now there is an opportunity to apply multiple information system modalities and to direct information to multiple stakeholders. The changes from one-to-one and one-to-many communications, to strategies that also include many-to-many communications modalities bring with them considerable challenges. In addition there is an expectation that emergency services will become more efficient in their information sharing with an increasing variety of stakeholders. For example, the community has an increasing expectation of real-time information and of receiving information in a variety of formats unknown ten years ago. Then, advice would have been given via radio broadcasts and community meetings. Now, in addition to those modalities, there is an expectation that information will be provided on the internet; sent through text message alerts, as well as communication through social media such as Facebook, Twitter and You Tube. All of these modalities are also available to operations personnel and some of them are approached with understandable trepidation.

Before it is possible to consider information systems applications and interface issues, it is important to understand the nature of the activities and challenges facing personnel who work at regional and state/national levels in the emergency management system. This is particularly important because the work demands and challenges of personnel working above the IMT level remain largely uncharted.

This report will concentrate first on outlining an activity analysis of personnel working above the IMT level and the challenges for information flow between the layers of the emergency management system. It will then discuss the implications for information systems. Later phases of the research will pick up on the interface issues in more detail and consider potential future applications.

### **Defining layers in emergency management coordination**

In many jurisdictions, IMT work occurs at a local level and other layers in the emergency management framework operate in administrative or geographical boundaries defined at regional and state levels. However, not all jurisdictions employ a regional layer and the challenge is therefore to attempt to define and categorise work occurring at these different layers that are qualitatively different.

Command and control structures can be divided into different levels; those being tactical, operational and strategic, and where different types of demands and decisions are bounded, in part, by different timescales (ISO 22320, 2011; Paton & Owen, in press) – see Table 1.



**TABLE 1 LAYERS OF COMMAND AND CONTROL STRUCTURES IN INCIDENT MANAGEMENT**

<b><i>Layers of emergency management</i></b>	<b><i>Description</i></b>	<b><i>Australia/New Zealand application</i></b>
Operational	First responders; front line personnel working directly on the fire or incident ground	First responders; incident ground personnel
Tactical	Local level incident management work directed at developing an incident action plan to contain or mitigate the event.	IMT
Strategic	Activity occurring above the local operational and tactical level that may involve regional and state-based activity. Concern for addressing the strategic issues across the whole-of government and community	Regional/State National (NZ)

In terms of Table 1, those working on the fire or incident ground undertake operational activities. Personnel working in an incident management team are developing and procuring resources to manage the tactics needed in managing the incident. Above the local incident level are those personnel engaged in considering broader implications of the event and who are thus engaged in activities directed toward strategic emergency management. Within Australian and New Zealand jurisdictions this strategic incident management work occurs at state levels in Australia and at a national level in New Zealand.

The purpose of this research work therefore is, in part, to articulate the activities and challenges involved in personnel involved at regional and state/national levels in terms of their strategic roles and how these connect with those tactics managed locally at the incident. It will be shown later in this report that part of the challenge for those personnel who do operate at a regional level is that they are caught both betwixt and between both local-tactical and state-strategic considerations, thus making the regional role particularly complex in meeting these different demands. The information systems implications of these findings will then be discussed.

### **Analysing information flow in complex socio-technical systems**

There are a number of different models that can be applied to conduct an analysis of information systems and their implications in complex socio-technical environments. There are, for example, formal models of articulating human-machine interaction and

operator needs through the processes of hierarchical task analysis (Kirwan & Ainsworth, 1992); of considering the socio-technical system as a joint cognitive system between human and no-human agents in terms of cognitive process engineering (Hollnagel, 2001), work domain analysis (Vicente, 1999) and cognitive work analysis (Stanton, Jenkins, Salmon, Walker, Revell & Rafferty, 2009).

Hollnagel (2011) makes the point that these models have been based on a number of assumptions that, due to complexity and interdependency, are becoming increasingly irrelevant. These assumptions are that (1) system boundaries can be well defined; (2) internal and external interactions of the system are similar; and (3) that humans and machines operating within these systems are reactive to stable inputs from their external environments. He goes on to argue that these are reasonable assumptions for systems that are tractable and which are relatively independent and only loosely coupled to their environment. However, they are not tenable for systems that are more open-loop and are more tightly coupled to their environment. Increasingly, human-machine systems are interdependently complex and needing to adjust to changes in their environments. It is this type of domain that emergency services organisations best represent. According to Hollnagel (2011) the design (and here – the review of) such systems needs to be more global in perspective; because the goals change from maintaining local stability to one of persistence – defined as the ability to absorb change and disturbance and still maintain an effective relationship with the external environment.

In keeping with Hollnagel's (2011) critique therefore, the approach taken here is one of aiming to unpack the decisions/actions undertaken by personnel, the challenges they face and how information systems are in use and/or could be deployed to better support the goals. This more global perspective is also necessary because each state level jurisdiction organises their coordination centres with slightly different roles and responsibilities. These will be analysed in a related report examining the different Incident Management approaches used and will be provided later in 2012.

## **A conceptual framework**

The conceptual framework employed for the analysis will be one developed by Boy (1998; 2011). The key issue in this framework is to track how various artifacts (i.e. the systems in use to convey and receive information) are employed to support personnel fulfilling their tasks and role responsibilities when engaged in strategic incident management. This framework uses the intersections between four elements: the task, the artifacts, the user and the organisational environment.

- **The Task.** It is important to understand the functional requirements of the task and its demands in order to consider how information system artefacts then support those demands. The focus here will be on the information needs

indicated in the decision-making responsibilities and challenges described by personnel.

- **The Artifacts.** In the context of emergency management, artifacts in use are those information systems that provide incident management resource databases; prediction tools, visual overlays of impacted areas and areas predicted. Included also are the vehicles through which such information may be accessed and communicated. This includes, for example radio, telephones, the internet, video, and/or teleconferencing; email, faxes, as well as face-to-face meetings. In the context of this report the ways in which personnel gather information will be reported along with any differences found within the different layers of emergency management.
- **The User.** Users are personnel working in the various centres of coordination and control. They may have a functional role to perform within the jurisdiction with control over the event. They may also represent stakeholders with an interest or responsibility to the community for mitigating the consequences of the event. Users differ on a range of characteristics. These include demographics, experience, personal readiness (e.g., fatigue). They may undertake their roles full-time, part-time or seasonally.
- **The Organisational Environment.** The organisational environment includes the ways in which role responsibilities are either differentiated into specialist divisions (e.g., Hazmat) or integrated into various teams. Organisational environment also refers to the contextual (i.e., jurisdictional and legislative) horizons and constraints.

The building block of the conceptual framework is represented in Figure 1 which illustrates the relationships between the user, the task and the artifacts. The figure highlights three edges:

- Task and Activity analyses (at the intersection between the User and the Task or U-T);
- Information requirements and technological limitations (at the intersection between the Task and the Artifact or T-A); and
- Ergonomics and training procedures (at the intersection between the Task and the User or T-U).

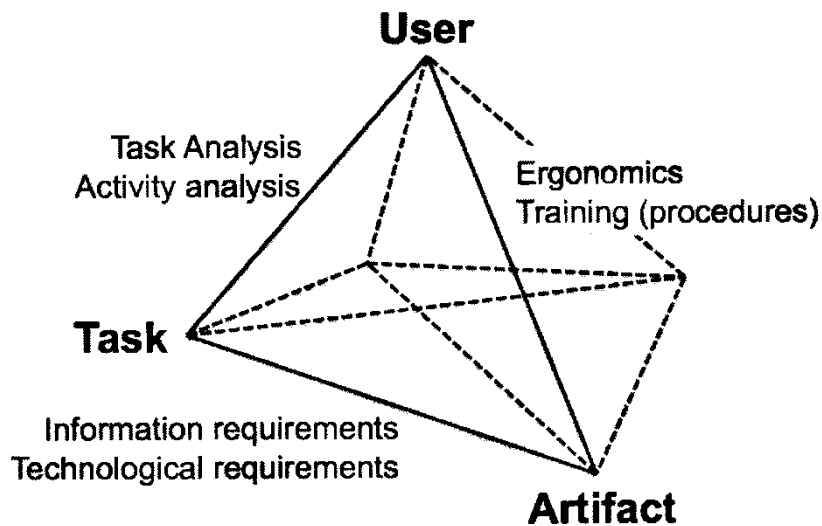


FIGURE 1 THE RELATIONSHIPS BETWEEN THE USER, THE TASK, AND THE ARTIFACT<sup>1</sup>

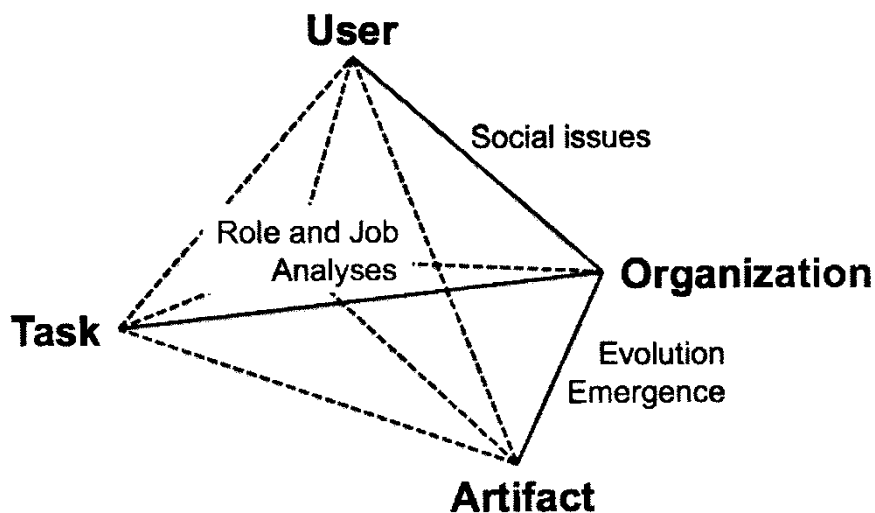


FIGURE 2 THE RELATIONSHIPS BETWEEN THE USER, THE TASK, THE ARTIFACT AND THE ENVIRONMENT<sup>2</sup>

In considering the implications of the organisational environment with the other elements, three more issues are illustrated in Figure 2.

- Social issues (i.e., between Users and their Organisation or U-O);
- Role and job analyses (Task and Organisation or T-O) and

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<sup>1,2</sup> Source: Boy, G. A. (2011). A human-centred design approach. In G. A. Boy (Ed.), *The handbook of human-machine interaction: A human-centred approach* (p. 7). Farnham: Ashgate.

- Emergence and evolution in terms of the technological affordances of Artifacts and their application within the Organisation (Artifacts and Organisation or A-O).

These figures illustrate the relationships that need to be addressed in any review of information systems implications and form the basis for this review. The first components – examining the relationships between the users, their tasks and their information requirements will now be outlined.

### **Analysing personnel information-related demands**

In terms of global tasks and responsibilities, the international standard for emergency management (ISO 22320, 2011) defines command and control “as activities of target-oriented decision-making, assessing the situation, planning, implementing decisions and controlling the effects of implementation on the incident” (p.2). It also defines coordination as “the way in which different organizations (public or private) or parts of the same organization work or act together in order to achieve a common objective” (p.2).

In keeping with the conceptual framework, a suitable vehicle to examine task and information-related demands is one developed by Rasmussen (1991). Rasmussen’s framework has been used in a range of information system analyses because of its suitability for dynamic and highly interdependent systems. It has been further developed by Hoc (1996) and others (Millot, Debernard & Vanderhaegen, 2011). According to Rasmussen (1991) the stages involved in managing unpredictable events includes tasks associated with:

1. Abnormal event detection, which includes searching for information;
2. Engaging in risk and situation assessment;
3. Task execution including goal and target definition and enacting, and procedures to complete execution;
4. Predicting and assessing consequences, planning for the future.

Hoc (1996) added a fifth stage, which involved activities associated with evaluating the progress of the goals and making adjustments. Given the emphasis on the need for system review and monitoring discussed in inquiries such as the Victorian Bushfire Royal Commission (Teague, McLeod, & Pascoe, 2010), evaluation will also be included here.

This model would seem quite suited to an analysis of strategic level emergency management given its emphasis on the responsibilities of abnormal event detection; situation assessment and prediction; as well as on task execution, sense-making and evaluation. However this assumption first needed to be tested.

The tasks associated with a framework of problem solving are also in keeping with theories of shared mental models in teamwork (see Owen et.al, under review; Burke, Stagl, Salas, Pierce & Kendall, 2006). Given that strategic incident management involves multiple teams and these teams interact within and between multiple organisations, teamwork is therefore an organisational mechanism to integrate particular functional responsibilities within complex socio-technical systems, which in the case of emergency management are represented as layers in the emergency management system.

## **Methods used**

The sources for this report include analysis of two organisational surveys and, where relevant inclusion of findings from a secondary sources analysis conducted by Brooks, Owen, Bearman & Grunwald (2011) and Grunwald & Bearman (2011).

In the first organisational survey 206 experienced personnel across a range of jurisdictions and states in Australia and New Zealand were asked to provide an outline of their activities and challenges in their main roles in a recent incident. This yielded comments from participants working at state/national levels (n=30); regional levels (n=49) and local levels (n=58) of incident management. For the purposes of this report the 79 participants working at regional and state/national levels made 120 comments and these have been included in the data analysis.

A second organisational survey, undertaken by the Office for the Fire Services Commissioner in Victoria, was also used because it provides a more detailed case study of the information needs of the various stakeholders involved at state and regional levels in one multi-jurisdictional location. The data reported here is a recoding and re-analysis of components of that survey. Victorian participants were asked to nominate the role they most commonly perform in an incident and to list the three most important decisions/actions they make in that role. Only personnel who were engaged in work at a state or regional level were included in this analysis (state, n=80; regional, n=23) and they yielded 160 comments. To begin, it is necessary to identify a suitable framework to guide the analysis and discussion.

## **Analysis**

The Rasmussen/Hoc framework was employed as a departure point for the analysis of the various demands and challenges discussed in the two surveys. The framework provided a useful way of grouping the data, however thematic modifications were needed to represent the emergency management domain. Sub-categories were then developed inductively based on the data. The modified problem-solving activities and examples from the data are presented in Table 2. The following table (Table 3) outlines the numbers of comments made that were coded at each of the categories

for the two survey cohorts. The sub-categories developed and their implications for information systems will be discussed in the rest of this report.

**TABLE 2 PROBLEM SOLVING MODEL INCLUDING ACTIVITIES AND EXAMPLES FROM THE DATA**

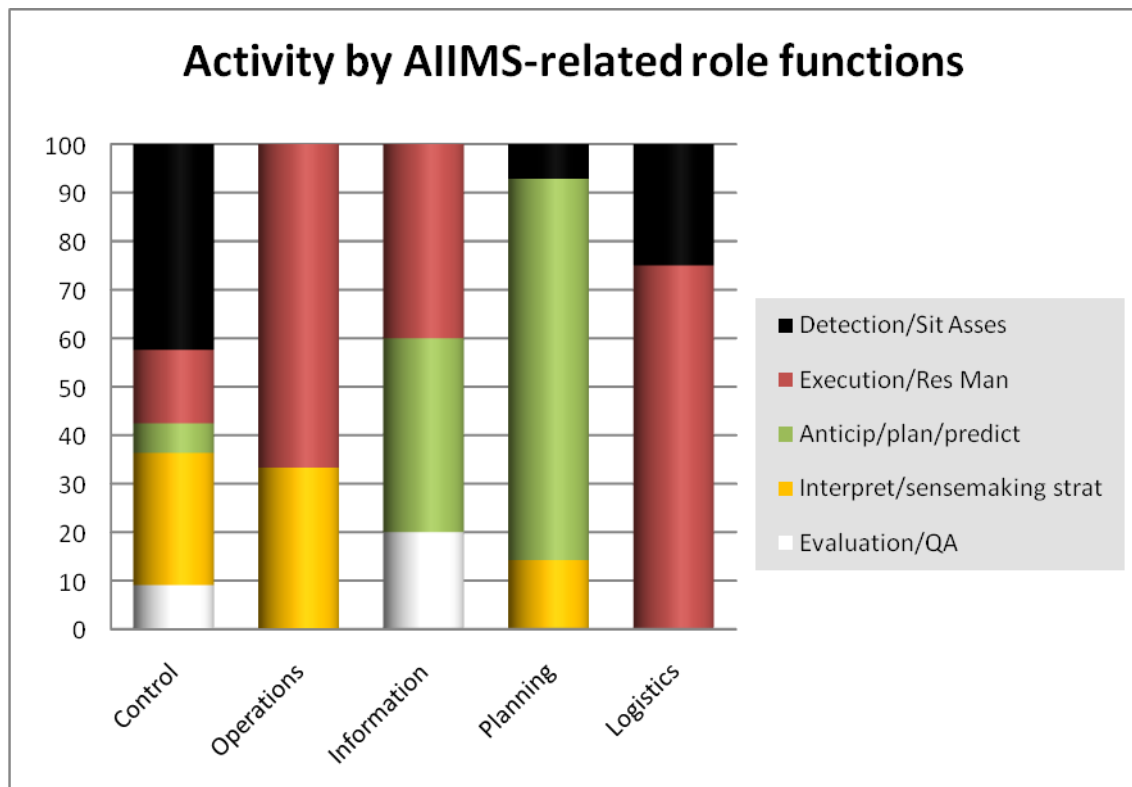
<i><b>Problem solving activity</b></i>	<i><b>Examples from the data</b></i>
1. Problem detection including situation assessment, size up – current assessment of risk	<ul style="list-style-type: none"> <li>• Determination of incident criticality</li> <li>• Ascertaining correct and up to date information on the incident</li> <li>• Identifying &amp; managing risk</li> </ul>
2. Execution of tasks, includes resource management	<ul style="list-style-type: none"> <li>• Dispatch and deployment of aircraft to fires and emergencies</li> <li>• Where your resources are established on the scene</li> <li>• Deployment of resources</li> </ul>
3. Anticipation/planning/prediction	<ul style="list-style-type: none"> <li>• Assessment of likely flood impacts</li> <li>• Exposures - Strategies to protect life and property</li> <li>• What is the likely fire behaviour</li> </ul>
4. Interpretation and sense-making – consequences for system goals - development of strategy	<ul style="list-style-type: none"> <li>• Information to the community - website/warnings</li> <li>• Which information to pass on to the public and how might it be communicated to ensure a clear message</li> <li>• What is the extent of damage and implications?</li> </ul>
5. Evaluation in relation to system constraints - quality assurance measures	<ul style="list-style-type: none"> <li>• Making sure statutory obligations are being met and compliance with procedures</li> <li>• Processes of transfer of Control from the field are followed</li> <li>• Ensuring Commander / Controllers Intent at all levels are implemented</li> </ul>

**TABLE 3 PROBLEM SOLVING MODEL INCLUDING INFORMATION FLOW AND TYPE OF INTERACTION**

<i>Problem solving activity</i>	<i>National Survey</i>	<i>SCC case study</i>
1. Problem detection including situation assessment, size up – current assessment of risk	34 (28%)	34 (18%)
2. Execution of tasks, includes resource management	44 (37%)	43 (27%)
3. Anticipation/planning/prediction	14 (12%)	25 (16%)
4. Interpretation and sense-making – including issuing community warnings and development of strategy	20 (15%)	45 (28%)
5. Evaluation in relation to system constraints-quality assurance measures	9 (7%)	13 (8%)
Total	120	160

Before proceeding to examine these activities in detail it is useful to consider these activities and their relationship to the functional role responsibilities outlined in the Australasian Inter-service Incident Management System (AIIMS). For those persons who answered the question, it can be seen that the activities associated are concentrated within certain functional roles (see for example Planning in Figure 3). However, it is also important to note that key functional roles (e.g., those involved in incident control and information) are engaged with multiple activities. Given that the purpose of this body of work is to consider information-related demands and information systems implications, the focus here is on activities and their challenges, not on functional AIIMS-related roles per se. This is also important because, as the Figure below demonstrates, key information-related demands need to be integrated across functional roles. The way in which these personnel engaged in these functional roles use information systems to integrate their activities with others will be the focus of consultation in the next phase of this research component.





**FIGURE 3 ACTIVITY BY AIIMS-RELATED ROLE FUNCTIONS**

These activities for personnel working at regional and state levels will now be discussed in light of their implications for information flow between layers in the emergency management system. Issues found pertinent in the secondary sources analysis, where appropriate, will also be discussed.

### **Problem detection, situation assessment**

Of the 73 responses coded to decisions/actions relating to problem detection and situation assessment (see Table 3, no.1 above), three sub-categories were identified. These included understanding the nature of the problem; gaining intelligence to begin to consider the implications; and establishing communications with key personnel operationally involved in managing the incident on the ground.

**TABLE 4 EMERGENCY MANAGEMENT SUB-CATEGORIES FOR PROBLEM DETECTION**

<b><i>Information-related demands</i></b>	<b><i>Challenges for information flow between layers in the EM framework</i></b>	<b><i>Implications for information systems</i></b>
Establishing communication flows	<ul style="list-style-type: none"> <li>• Understanding who is where and doing what</li> </ul>	<ul style="list-style-type: none"> <li>• Radio and telephone overload, black spots, informal mobile phone use</li> </ul>
Situation assessment	<ul style="list-style-type: none"> <li>• Multiple incidents, rapid changes, slow information flow</li> <li>• Consideration of stakeholder needs, needs of public</li> <li>• Alerting personnel to transitions in incident activity (e.g., shifts toward escalation)</li> </ul>	<ul style="list-style-type: none"> <li>• Need for sit updates at regular intervals</li> <li>• Identification of new significant incidents</li> <li>• Represent transitions in incident activity (anomaly detection)</li> </ul>
Intelligence gathering	<ul style="list-style-type: none"> <li>• Impact assessment of risk</li> <li>• Information gaps, inconsistencies</li> <li>• Time lags</li> </ul>	<ul style="list-style-type: none"> <li>• Establishment of rapid impact databases</li> <li>• Need for anomaly detection</li> </ul>

Activities associated with problem detection comprised the second largest volume of activity reported (see Table 4). Gaining an appreciation of the incident was the uppermost concern. This was particularly problematic in events that were rapidly developing and dynamic in their changes. At regional and state levels of incident management it is important that personnel can gain an initial assessment of the impacted areas, and an assessment of the level of damage so that they may begin a process of risk assessment and consequence management. The problem here is that personnel on the ground are not easily able to provide this information if they, too, are in the midst of an emerging situation. This can create challenges for both situation assessment and gathering intelligence to feed into further strategic incident management processes.

In Rasmussen's (1991) framework the importance of anomaly detection was highlighted. In respect of the sub-categories represented in the above table, this would be a combination of activities associated with situation assessment and intelligence gathering. It is interesting to note that the emphasis for the participants in the survey seemed to be a concern simply to understand what was happening, much less about what might be starting to be anomalous with the management of the incident. Given the responsibilities of personnel above the IMT to provide supervisory support as well as quality assurance, this would seem to be an important area for future information systems design.

## Task execution, resource management

Of the 84 responses coded to activities associated with executing tasks and managing resources needed for task execution (see Table 3, no.2), three sub-categories were identified. This represented the largest volume of work activity identified in the coded comments made by participants.

The focus here is largely on resource management (see Table 5). Invariably there are not sufficient resources to address the situation at hand and personnel operating at regional and state levels need to prioritise and make do with what is available. This results in competing priorities within regional and state centres in order to meet operational, community, government and political expectations. Immediate consequence management is also a concern.

**TABLE 5 EMERGENCY MANAGEMENT SUB-CATEGORIES FOR TASK EXECUTION**

<i>Information-related demands</i>	<i>Challenges for information flow between layers in the EM framework</i>	<i>Implications for information systems</i>
Managing resources	<ul style="list-style-type: none"> <li>• Insufficient resources</li> <li>• Fatigue management</li> <li>• Lack of capability and assessing existing capability</li> </ul>	<ul style="list-style-type: none"> <li>• Resource management tracking, particularly in multi-jurisdictional events</li> </ul>
Managing competing priorities	<ul style="list-style-type: none"> <li>• Prioritisation of resource requests</li> </ul>	<ul style="list-style-type: none"> <li>• Priority assessment mechanisms</li> </ul>
Managing systems	<ul style="list-style-type: none"> <li>• Duplication of processes, manual handing of the same information by different stakeholder agencies</li> <li>• Other agencies not knowing the arrangements or their role responsibilities</li> <li>• Failure of existing incident management arrangements to identify consequences and report up</li> </ul>	<ul style="list-style-type: none"> <li>• Stakeholder data-base for on flow effects</li> <li>• Alerting systems for non-operational but implicated organisations</li> <li>• Clarity in actions/ and related responsibilities emergency management partner organisations</li> </ul>

Regional and state levels spend considerable effort on procuring and managing logistical issues, frequently with their own teams undermanned. Coordination of interstate and international deployments, for example, is managed at the state/national level as well as the need to consider, for some agencies, the procurement and rostering of additional volunteers.

It is when engaged in these activities that difficulties in the interfaces of Computer Aided Dispatch (CAD) systems with both dispatch and deployment responsibilities become visible and add to the complexity of task execution. In addition, duplication of

processes that require repeated manual handling of the same information slows down capability for action.

The issue of capability management was raised as problematic in the secondary sources analyses undertaken by Brooks et.al. (2011). In his assessment of both the ACT fires and the Kilmore East fire in Victoria 2009, Brooks showed how accessing the personnel needed, with the right levels of competence, and having this information easily visible was particularly challenging.

### **Anticipation and prediction for future states**

Of the 39 responses associated with activities of anticipation and prediction, three sub-categories were identified (see Table 6).

**TABLE 6 EMERGENCY MANAGEMENT SUB-CATEGORIES FOR ANTICIPATION AND PREDICTION**

<i><b>Information-related demands</b></i>	<i><b>Challenges for information flow between layers in the EM framework</b></i>	<i><b>Implications for information systems</b></i>
Gaining and maintaining situation awareness	<ul style="list-style-type: none"> <li>• Developing predictions with incomplete /inconsistent information</li> </ul>	<ul style="list-style-type: none"> <li>• Feed-forward modelling and scenario modelling available in a readily assessable format and easily distributable to stakeholders</li> </ul>
Determining potential impacts	<ul style="list-style-type: none"> <li>• Developing triggers for use when anomaly detection requires transition to escalation</li> <li>• Locations for evacuations;</li> <li>• Contingency planning</li> </ul>	<ul style="list-style-type: none"> <li>• GIS data with stakeholder overlays</li> <li>• considering the magnitude potential</li> <li>• Inter-connectivity within emergency management command and control frameworks</li> </ul>
Developing strategic plans	<ul style="list-style-type: none"> <li>• Inadequate resources to achieve predictions</li> <li>• Goal and priority conflicts</li> </ul>	<ul style="list-style-type: none"> <li>• Accessibility of key impacts, triggers and time frames for non-operational agencies</li> </ul>

Given the challenges associated with gaining an assessment of the situation, it is not surprising to learn that personnel operating above the IMT raised concerns relating to difficulties in gaining and maintaining situation awareness and in being able to use this awareness to determine potential impacts and developing strategy. Part of the difficulty here related to a frequently reported problem of accessing resources to be able to perform these tasks at regional and state levels.

## Interpretation, sense-making and the development of strategy

Activities associated with interpretation, sense-making and development of broader strategy accounted for 64 responses across the two studies (see Table 3, no.4) or 23% of the volume of demands reported. Two sub-categories are reported here (see Table 7 below).

Participants reported that naming up and managing competing interests was a particular challenge, especially in assisting political and community expectations of operational personnel (e.g., “fire-fighter safety vs public safety”). In addition, the way in which the regions and states are able to translate operational incident activity to assist other groups to understand the impacts or implications was a key concern.

**TABLE 7 EMERGENCY MANAGEMENT SUB-CATEGORIES FOR INTERPRETATION AND SENSE-MAKING**

<i>Information-related demands</i>	<i>Challenges for information flow between layers in the EM framework</i>	<i>Implications for information systems</i>
Developing a State strategy	<ul style="list-style-type: none"> <li>• Competing priorities across different agency and political interests</li> <li>• Interagency liaison</li> <li>• Conflicting levels of risk tolerance between agencies</li> </ul>	<ul style="list-style-type: none"> <li>• Making visible decision-making on prioritisation, competing interests and agreed direction</li> </ul>
Providing meaning for different stakeholder groups	<ul style="list-style-type: none"> <li>• Identifying warnings to the community</li> <li>• Translating key messages to media, to whole of government and to politicians.</li> </ul>	<ul style="list-style-type: none"> <li>• Up to date timely feeds and displays that are accessible and translated</li> <li>• Streamlining processes for emergency alerts to the community</li> </ul>

A considerable amount of attention and effort goes into ensuring that warnings are appropriately conveyed to different groups, including affected communities. A higher level of attention to this form of meaning-making was reported in the Victorian study. Effort was also expended on ensuring that key stakeholder groups were engaged and had a clear understanding of the issues and their potential.

Boundary spanning roles were particularly important as are other mechanisms to bridge different positions, intentions, needs and interests, including aligning strategic goals with existing Government policy goals. Providing updates and meaning with situational advice for stakeholder groups was reported as particularly important.

Differences were also reported as challenges for different stakeholder groups in the interviews currently being conducted as part of the overall research project. While

many operational personnel can gain a considerable amount of meaning from interpreting a map and its projections, external stakeholders reported that many were unable to gain this same level of meaningful understanding from looking at, for example, a fire prediction map. The need for translation across boundaries was regarded as important for non-combat personnel involved with a responsibility for managing other services.

## Evaluation and quality assurance

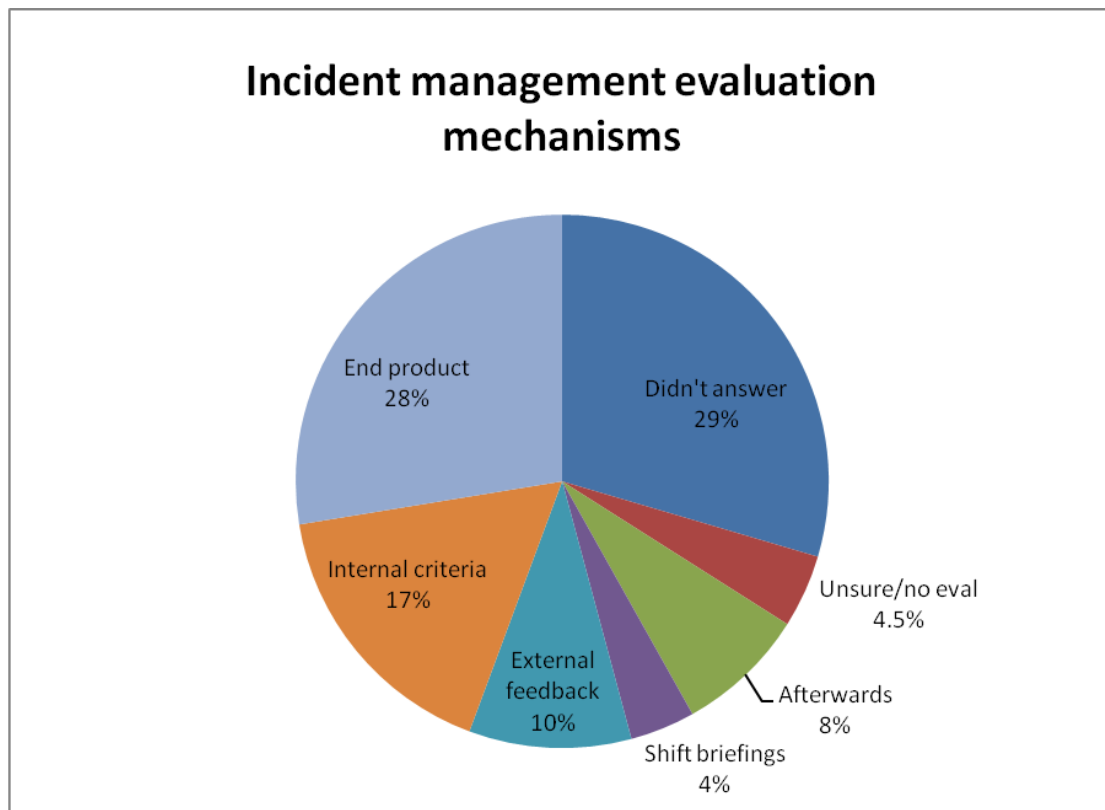
The number of responses coded to activities associated with evaluation and systemic quality assurance of the emergency management arrangements was relatively small, amounting to 21 responses (see Table 3, no.5). These could be coded to two sub-categories; monitoring safety health of incident management and quality assurance.

**TABLE 8 EMERGENCY MANAGEMENT SUB-CATEGORIES FOR EVALUATION**

<i>Information-related demands</i>	<i>Challenges for information flow between layers in the EM framework</i>	<i>Implications for information systems</i>
Monitoring safety health of incident management	<ul style="list-style-type: none"> <li>• Inaccessible information, not timely</li> <li>• Challenges in knowing whether or not actions have been completed and information loops have been closed</li> </ul>	<ul style="list-style-type: none"> <li>• Tracking of processes providing a snapshot of level of activity indicating health of system (e.g. lags between requests and completions)</li> <li>• Snapshot of the status of current State-level activity making visible potential pressure points in incident activity (# 000 calls unanswered)</li> </ul>
Quality assurance	<ul style="list-style-type: none"> <li>• Incomplete information, withholding of information</li> </ul>	<ul style="list-style-type: none"> <li>• Electronic tracking of IAP's displays of status of incidents and warnings (e.g., requested, pending and complete)</li> </ul>

There was a need to assess the information collated on the management of the incident to ascertain if statutory obligations were being met and that there was compliance with procedures. Activity also included ensuring that the appropriate command and control arrangements were in force particularly with community warnings; i.e., that the right level of warning was appropriate to the incident as it was developing. Ensuring that the incident is being managed appropriately is also identified as important (see Table 8).

Evaluation to assure the safety health of managing incidents at regional and state levels of incident management requires further attention. In the national organisational survey a question was included that sought advice on what evaluation mechanisms were in place to know whether or not the objectives were being achieved. The results are presented in Figure 4.



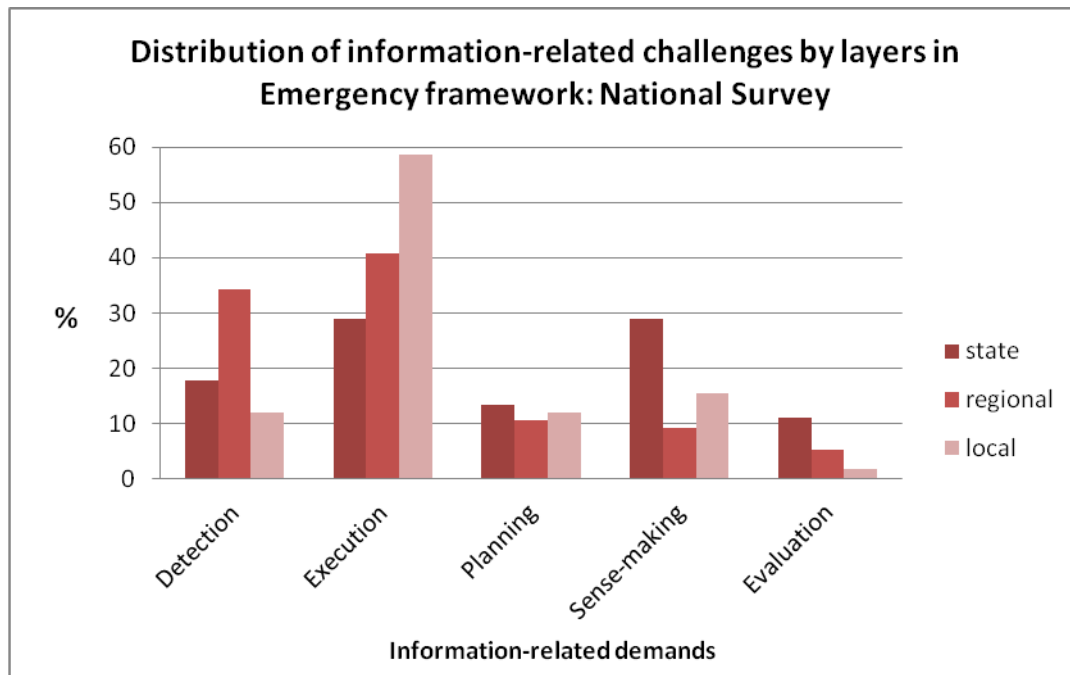
**FIGURE 4 INCIDENT MANAGEMENT EVALUATION MECHANISMS AS REPORTED IN THE NATIONAL ORGANISATIONAL SURVEY**

It is interesting to note that close to 30% (n=57) of participants did not answer the question. It can be speculated, then, that those persons might be grouped with the 4.5% (n=9) who stated that they were either unsure or did not believe that any evaluation took place. The figure also shows that 8% (n=16) of participants explained that the evaluation process occurred after the event in after-action reviews. There were 20 (10%) participants who commented that their evaluation measures were based on the feedback of others. There were 21% of participants who stated that some form of evaluation occurred during the event, either in briefings (n=8; 4%) or through assessing key indicators (n=34; 17%). Of concern are the 56 participants (28%) who conflated evaluation of progress with the outcome. Comments such as “the job got done in the end” or “we pulled it off” illustrate the thinking of some of these participants. These findings highlight a particular risk. If the job was successful, then participants deemed that they performed well. However, in many industries this has been found to be a flawed process (Dekker, 2006; Hollnagel, Woods & Levensen, 2006). The outcome might have been successful despite risks and unsafe practices being undertaken.

### **Information-related demands across layers in emergency management**

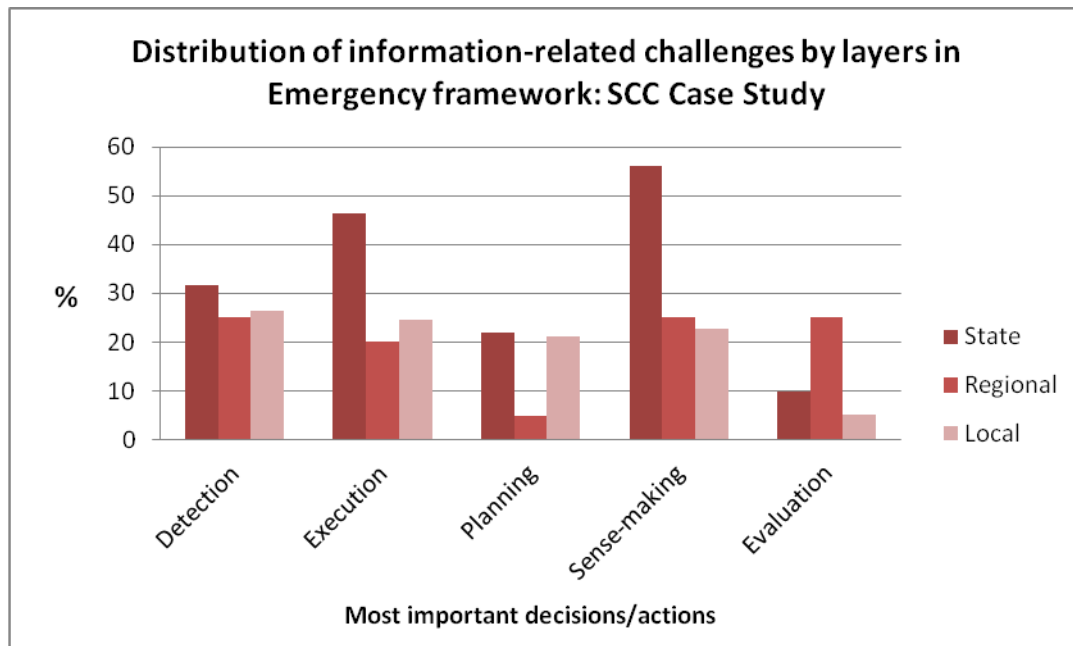
The challenges mentioned in the national survey and the most important decision/actions mentioned in the SCC survey were again reviewed to gain an appreciation of the distribution of activities across the layers in the emergency

management system, and this time the comments from those personnel operating at a local level were also included. It can be seen from Figure 5 that those personnel operating at a local level are, not surprisingly, most heavily engaged in executing tasks; whereas those engaged at state level are engaged equally across activities associated with execution and sense-making; while those working at regional level are most engaged with problem detection and execution. In contrast, the SCC Victorian study showed that state level personnel were sense-making as well as engaged in task execution; and regional personnel work equally across problem detection; task execution, sense making and evaluation (See Figure 6).



**FIGURE 5 DISTRIBUTION OF INFORMATION-RELATED CHALLENGES BY LAYERS IN THE EMERGENCY FRAMEWORK: NATIONAL ORGANISATIONAL SURVEY**





**FIGURE 6 DISTRIBUTION OF INFORMATION-RELATED CHALLENGES BY LAYERS IN THE EMERGENCY FRAMEWORK: SCC CASE STUDY**

It will be important in the next phase of this research work to examine the types of information systems modalities personnel use to support these activities and to consult with industry personnel about whether they believe the mix of activity is appropriate for differing levels of emergency management.

## Conclusion

The focus of this report has been on attempting to map out the information-related demands and challenges facing personnel working at state and regional levels in Australia and national levels in New Zealand. The analysis has identified a number of challenges associated with problem and anomaly detection in situation assessment; resource management; modeling for future predictions; managing competing goal conflicts and competing interests; as well as the need to better develop indicators of evaluation.

The second phase of this research component will:

- Consult with industry personnel on the confirming of contents of the information demands and challenges reported here for regional and state levels;
- Analyse the various information modalities available and map the relationships between information system use and activity;
- Discuss the findings of this component with industry stakeholders to identify the possibilities and constraints of information systems for the future.

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