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Understanding decision making during emergencies: a key contributor to resilience

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Understanding decision making during emergencies: a key contributor to resilience

Abstract

The resilience of systems derives from many inputs, relating both to design and to operational planning. In the latter context the role and effective functioning of the 'blue light' emergency services is often critical. The judgements and decisions that have to be made are complex and time-constrained, often undertaken before all the critical information that might be wanted is available. Recent developments in decision research, notably the on-going dual process debate, suggest that the process of decision making adopted is often more complex than had previously been appreciated and strongly linked to both context and individual factors, notably expertise. In the light of such developments, this paper presents an empirical study of emergency responders working in realistic, non-laboratory conditions. It argues that recent moves to recognise the need to support, through the way in which information is provided, more intuitive as well as analytic modes of thinking in decision support are timely and that an important research agenda exists linking decision support design with a fuller understanding of exactly how individuals make their decisions in emergency conditions.

1. Introduction

Societies' ability to deliver a resilient response to unexpected major disruptions to any of its major infrastructure is underpinned by many planning decisions made well ahead of the disruption, as well as by operational decisions in the immediate aftermath of an incident. At least three factors are at play and potentially interact with each other. The physical design of the infrastructure system itself is central, but important also are the operating procedures in place for the infrastructure and the way in which emergency response to an incident is planned and executed.

This paper focuses on the last of those three, emergency response to incidents that may jeopardise the functioning of critical infrastructures. It focuses in particular on the information available to those responsible for responding to the emergency, how they use that information to inform their decision making during the emergency, and then subsequently justify the decisions taken. It is therefore relevant to resilience at two levels. Firstly, if the emergency itself potentially affects critical infrastructure functioning, then the focus of the overall activity is directly on supporting resilience. Secondly, the focus of the immediate research activity reported here is to underpin a resilient system for the emergency response itself in that it is seeking to understand the information available to support emergency response, the information behaviour exhibited by key actors overseeing and executing the response, and specifically the interplay between information provision, information use and decision making. The ultimate aim of the work is to improve the decision making guiding the work of emergency response teams in what is a complex, dynamic and time-constrained field of activity.

The volume and range of decision research, aiming to understand more fully the processes employed when individuals and groups make judgements and decisions, has grown substantially. Important early work in terms of emergency response includes the work of Klein

and colleagues on Naturalistic Decision Making (NDM), particularly Recognition Primed Decision Making and the influence of expertise. More recently, other decision researchers have developed ideas in relation to Type 1 (essentially intuitive) and Type 2 (essentially analytical) modes of decision making and have examined whether and how each or both of these modes of thinking may be employed in relation to particular decision tasks (see, for example, Hodgkinson *et al.*, 2009; Salas *et al.*, 2010).

In this paper we explore this growing understanding in the context of one particular class of emergency response decisions, with an emphasis on information behaviour: how do the decision makers concerned seek and use information and in turn what does this imply for the achievement of a resilient response to major unexpected events? We present evidence that suggests a mismatch between the (more intuitive) decision making processes often employed in practice and the (more analytical) processes incorporated in formalised procedural guidelines. We endeavour to throw light on the nature of and reasons for the mismatch, using the analysis of a series of practitioner accounts of their own decision making. We conclude that there is an important need to reconsider process support in the light of this mismatch and in this respect provide evidence from a practical application context that is broadly supportive of the line of thinking developed in Perry *et al.* (2012).

2. The decision making context

Emergency management can be categorised into the four phases of mitigation, preparedness, response and recovery (see Warfield, 2003 for further information). The interest of the present research is in the response phase, where immediate assistance is provided to minimise the hazards created by the disaster viz., evacuation, emergency relief, search and rescue, thus supporting societal resilience in the face of an emergency. This is a phase where critical, complex and dynamic decisions have to be made in a time constrained environment (Comfort *et al.*, 2001; Greitzer *et al.*, 2010).

The research studies the Emergency Services in the UK. Within the response phase, the UK Civil Contingencies Act 2004 specifies Category 1 responders (the blue light services viz. police forces, fire and rescue services and the ambulance service, along with local authorities and environmental agencies) and Category 2 responders (utilities, highway agencies, the Red Cross, army, telecommunication companies and other government agencies). At the time of undertaking this research, Category 1 responders were further classified as gold (strategic), silver (tactical) and bronze (operational) levels, see Figure 1. In any major incident, there will be many operational level commanders responsible for the crew on the ground. Tactical commanders from each emergency service will be appointed and one gold command may be identified, but only in major incidents.

Strategic Level (Gold Commander)

Tactical Level (Silver Commander)

Operational Level (Bronze Commander)
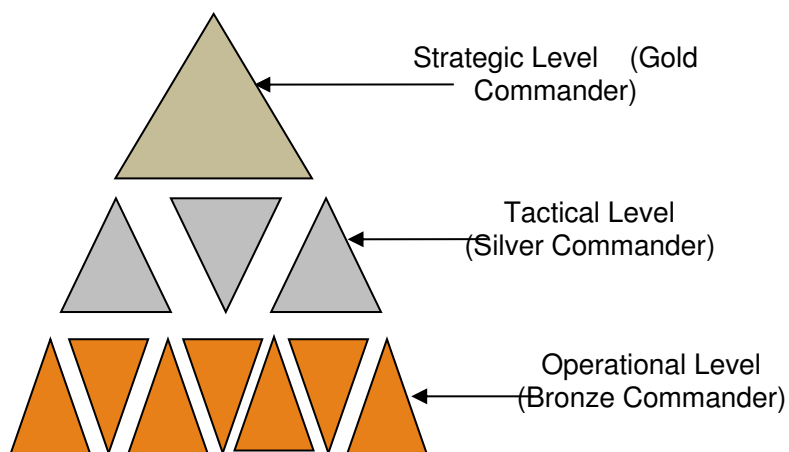
Figure 1. Command structure of the emergency services in the UK

The current paper focuses on silver commanders as they are the coordinators of incident response and, because they need to make many tactical decisions in complex, uncertain and time constrained environments, their decision support needs are particularly challenging. They may well be working with other silver commanders with whom they have not worked before and with sub-ordinates not all of whom they may know. To make effective decisions, they need timely and accurate information. They also need to command and control their bronze commanders and simultaneously to formulate tactics so that the strategy set by any gold command is met (LESLP, 2007). With concurrent incidents occurring during the

5

response phase, the work task of silver commanders becomes very complex. Uncertainty is also high, as every incident is to a degree unique.

A further important influence is the Conflict Management Model (CMM) used by the UK emergency services   According to the manual of guidance, the 'CMM provides a framework for recording command decisions and the rationale behind them' (NPIA, 2009). The CMM starts with the information being received by the silver commander, and then aids in assessing the risk and threat. Based on the policies available and the risk assessment, silver commanders then need to sort out their tactical options. For each tactical option a threat assessment must be undertaken. The decision making process follows the Lobster Pot pattern (as shown at the bottom of Figure 2) using a filtering/elimination process via which the most promising tactical option is chosen and then applied. This is a continuous process and is maintained until the incident is brought under control.

Officials acknowledge that the CMM model cannot always be used, especially in a 'dynamically evolving incident, during which professional knowledge, skills and experience' developed in the service should be used (ibid). This acknowledgement lies at the core of the argument to be developed in the following three sections.
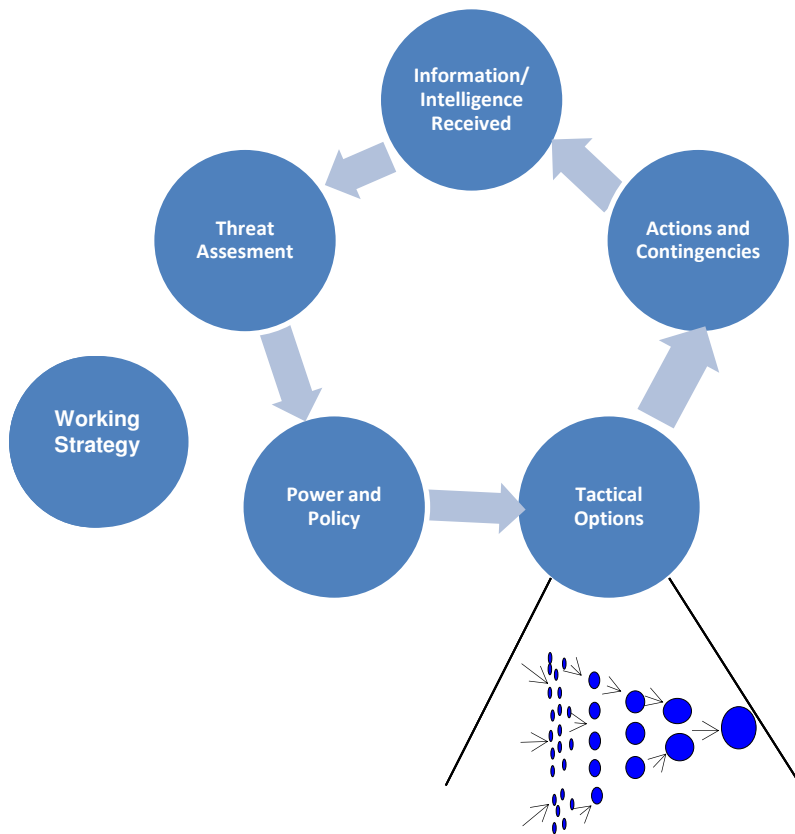
Figure 2. Conflict Management Model (CMM)

Within this general context, there is ample academic and professional evidence to support the view that resilience of response is undermined by a series of factors that lie at the interface between information provision, information use and decision making. Information gathering and sharing can break down within and between teams and agencies (e.g., Lundberg and Asplund, 2011). This information loss can undermine situational awareness and coordination, leading to poorer incident management and decision making (Comfort, 2007; Wybo and Latiers, 2006). The resilience of emergency response systems is degraded (Kanno and Futura, 2006).

3. Developments in decision process research

The volume and range of work in decision research has grown enormously in recent years. At one time, it was standard practice to categorise analysis of decision making simply as either *Normative* (based on axioms of rational behaviour aiming to describe how individuals *should*

make decisions between alternatives), *Descriptive* (concerned with what individuals and groups of decision makers actually do in practice) or *Prescriptive* (concerned to try to help decision makers behave in a way that is closer to the normative/rational 'ideal' than they might do unsupported). Implicitly or explicitly, the characterisation of decision making was largely static and somewhat abstract, aiming to understand and/or support largely individual, one-off choices. While such understanding undoubtedly has some value, the failure to recognise, e.g., the interdependence of decisions and the importance of factors like expertise, teamwork, provision of information and decision context, in other words, a lack of focus on decision *process,* severely limits early decision research's ability to give applicable insights about many types of real-life decision. However, developing from the work of researchers such as Simon (1955) but largely and more recently Tversky and Kahneman (1986), a growing volume of evidence and potential explanation has been established relating to how individuals and groups *actually* make decisions in more life-like environments.

To understand and to seek better to underpin effective decision making processes in the particular area of emergency response to which this paper relates, three areas of academic debate that focus on the realities of decision making are important. They are respectively *naturalistic decision making*, *dual process theory* and the link between these two and *information behaviour*.

3.1 Naturalistic Decision Making

One area where the distinction between early characterisations of decision making and observed reality is stark, and where the influence on ways to facilitate societal resilience is direct, is in relation to time-pressured decision making, especially by experts. Naturalistic decision making (e.g., Klein, 1997a; 1998) and particularly Recognition Primed Decision Making (Klein, 1997b), posit an understanding of how decisions are made which is quite different in kind from the theoretical normative models, prescriptive frameworks such as the

lobster pot model, or indeed 'quasi-normative' descriptive models such as Kahneman and Tversky's Prospect Theory.

In NDM, as Endsley (1997, p. 269) states, decisions are made using 'a holistic process involving situation recognition and pattern matching to memory structures to make rapid decisions'. NDM studies how people use their experience to make decisions in field settings Gore *et al.* (2006, p. 926). Greitzer et al. (2010, p. 280) state that in broad terms highly experienced people process information at the subconscious level and do not need to 'interpret and integrate cues or consider possible alternate actions' whereas moderately experienced people use a rule base approach (if – then) and novices tend to use a knowledge base approach (more analytical).

Within NDM, Klein proposed Recognition Primed Decision Making (RPDM) to 'describe how people can use their experience to arrive at good decisions without having to compare the strengths and weaknesses of alternative courses of action' (Klein, 1997b, p.287) in circumstances that are time critical, with ambiguous information and ill-defined goals. In the RPDM model, the current situation is matched with a pattern created in the mind derived from recall of influences such as expectation, plausible goals, relevant cues and typical actions. If the situation matches a previous pattern, then the relevant course of action is implemented.

This way of framing a decision task has overtones of sensemaking, the process by which people give meaning to experience, and which has been explored in the context of both information science (e.g., Dervin, 1996) and organizational studies (e.g., Weick, 1995) and, indeed, by Klein and colleagues (Klein *et al.*, 2006). It is particularly relevant to circumstances where decision making is being undertaken in time constrained and complex conditions, such as those faced by the silver commanders at the focus of this study. Other researchers (e.g.,

Gartska and Alberts, 2004) have seen sensemaking as critical to certain military network-centric operations, arguing, for example that the quality of shared sensemaking and collaboration will be better in robustly networked contexts, thus empowering people to make better decisions.

A closely related context in which the ability to respond effectively to information in potentially demanding circumstances is critical is interface design. For example, the Skills, Rules, Knowledge (SRK) framework introduced by Rasmussen (e.g., Rasmussen, 1983) facilitates less experienced people more easily to acquire advanced mental models of a situation and is used to determine how information should best be displayed to take advantage of human perception. Similarly, there is interesting related work on situational awareness, exploring capability to comprehend situations prior to decision making, initiated by Endsley (1995) and further investigated, e.g., in Kaber and Endsley (2003). This research explores the trade-off between workload and situational awareness, arguing, for example, that in certain circumstances an increase in workload can divert resources from maintaining situation awareness and so decrease the latter), but a well-designed interface display can both reduce workload and increase situation awareness.

This body of work in general serves to emphasise that, especially in emergency decision making but more generally too, understanding of context and process is central to effective decision making and to effective decision support and that the quality of a decision outcome is not simply a consequence of the immediate decision making act itself, but is every bit as much dependent upon factors such as situational awareness and information provision.

Hamm (1988, p.87) has argued that with more ill-structured tasks, people are more inclined towards intuitive decision making. Alby and Zucchermaglio (2006) put forward the suggestion

that under time pressure people act first and think later. Both these lines of argument are broadly consistent with the RPDM and related models. Moreover, to understand dynamic decision situations such as real-life emergency response, laboratory studies are rarely suitable. . Reflecting this, although some of the argument that follows builds on other researchers' laboratory-based behavioural studies, the core empirical evidence presented here derives from direct observation of silver commanders in environments that are as close to real life as can practicably be achieved.

3.2 Dual Process Theory

An active area of research in the last decade or so relates to what is commonly termed the dual process theory debate.

The key dichotomy in dual process theory is between different thinking modes for making decisions. Stanovich and West (2000) originally named these *system 1* and *system 2* decision making. Other researchers have presented the dichotomy as a distinction between *intuitive* and *analytic*, *experiential* and *rational,* or, *tacit* and *deliberate,* decision making, Hogarth (2010, p. 338), Evans (2008, p. 257). Evans suggests the terminology *type 1* and *type 2*, on the grounds that there are not necessarily two singular systems, rather each is a set of systems (Stanovich *et al.* (2011). Type 1 decision making refers to intuitively made decisions which might be from *instinctive knowing* such as a "hunch" or "gut feeling" (Shen *et al.*, 2012; Hammond, 2010, p.237) and where information is processed through 'non-conscious holistic information processing' (Sinclair 2010, p. 378) by relying 'on long term memory' (Allen, 2011, p. 2166). Incoming information or other cues are used to recognise and retrieve the pattern that is organised in an individual's mind. Decision making is not obvious as options are not analysed consciously. Alternatively, type 2 is a formal process in which analysis is done before reaching a decision and is applied using formal structures (Kahneman and Klein, 2009). In this type, the optimum decision is chosen using the available information. However, due to

the bounded rationality of humans, sometimes in this process people opt for satisficing (Simon, 1955), rather than optimising decisions.

In the view of Evans (2011, p. 88), the definition of type 1 in terms of non-conscious thinking (Sinclair, 2010, p.378) is a mistake. He argued that 'type 1 processing can lead to emotions and feelings of intuition which are conscious, even though the underlying processing is not accessible'. Evans (2011, p. 88) further stated that 'processing depends upon a number of rapid, unconscious support systems such as those which provide pragmatic cues to relevant context or retrieve relevant information from long term memory'.

According to Stanovich et al. (2011, p.105) type 1 encompasses 'procedures and experiential associations that have been learned to automaticity and can operate at once in parallel but type 2 processing is largely serial'. Citing Shiffrin *et al.* (1977) which described the earliest dual-process models, Stanovich et al. (2011, p. 108) state that during novel situations 'controlled processing (type 2) requiring active attention, being serial in nature' is needed.

This and other work reflects continuing debate on this important topic. Equally important is not to lose sight of the fact that, in practice, many real decision making processes will exhibit elements of *both* type 1 and type 2. It is not necessarily one *or* the other but possibly (a) some alternation over the process as a whole between types 1 and 2, or (b) use of decision making procedures that fall somewhere intermediate on the type 1 to type 2 spectrum, containing elements of both types of thinking (see, e.g., Sadler-Smith and Shefy, 2004).

In the still-evolving dual process debate, important differences remain of direct relevance to our understanding of decision making in emergency situations. In turn, there are also

important, related and unresolved questions regarding how information links to emergency decision making.

3.3 Information behaviour and decision making

Optimising how information is sought, provided and used lies at the heart of design for, and delivery of, resilience. Information search, provision and use, are highly interdependent and yet, in information science research, the extent to which recent developments in decision making, such as those outlined above, should inform information behaviour has been investigated by only a few researchers, notably Allen (2011) and Choo (2009). Allen (2011) in his research, drawing on the discussion on unitary and dual modes in dual-process theory (Hodgkinson *et al.*, 2009), proposed five different modes viz., intuitive; intuition led, supported by deliberative information behaviour; deliberative information behaviour moderated by intuition; truncated deliberate information seeking; and parallel (intuition and deliberate working together) (p. 2179). Linking his findings to Klein (1997b), he found that, despite explicit norms and rules that militated against any form of decision making other than analytical, during time constrained, complex and uncertain events, intuitive decision making was also employed, both in parallel and as an alternative strategy. On the other hand, Choo (2009) utilised the cognitive continuum theory proposed by Hammond (1996) in which intuitive and analytical cognitive styles are described in the context of a *continuum* between opposite poles (Hammond, 2010, p. 330) Choo used this theory as a lens to focus on detection accuracy in early warning systems.

3.4 Summary

As observed in the two preceding sections, different views are presented in the literature on type 1 and type 2 decision making in relation to decision making in emergency situations. RPDM, which has been shown to be effective in complex environments, is described as type 1 but also as type 2 by Evans (2008). Indeed, one of the major broader underlying and outstanding questions is precisely what is the relation between type 1 and type 2 processing

and how and to what extent are they used in competition with, or as complements to, each other either simultaneously or sequentially. Fuller understanding of these issues is arguably central to the facilitation of a resilient response to emergencies which in the real-life emergency response context described in section 2 manifests itself as a need to identify which type(s) of decision making are promoted to, and in practice applied by, silver commanders in the emergency services.

Information technology has substantially changed the availability of information in contexts like the one studied here. Indeed, Klein has even cautioned that use of technology may lead to *overload* of information: 'previously information was missing because no one has collected it and in the future (using technology), information will be missing because no one can find it' (Klein, 1997b, p.279). Nonetheless, linking information to decision making, he further added that in emergency situations, the main decisional errors derive from lack of experience; lack of information and *de minimus* error (Klein, 1998, p. 274). Klein's findings underpin this research. Lack of information and of experience are key, and interacting, factors.

Overall, this section has set out a summary of pertinent elements of the decision research and information science literatures. It has established the relevance of RPDM and has linked this to the recent and on-going debate around type 1 and type 2 modes of decision processing. The information science literature, on the other hand has generally paid less attention to the implications of the use or the appropriateness of more intuitive styles of judgement and decision making. The following two sections concern methodology, data and analysis in relation to exactly this question, in this way directly addressing some of the key research questions highlighted by this brief review of the area.

4. Methodology

<u>4.1 Activity theory</u>

The use of Activity Theory in this paper is both as a framework to structure the research questions and as an analytical tool. Activity theory has been used in various information studies since the late 90's (Wilson, 2006, p. 144) and as an overarching framework for understanding information behaviour (Allen *et al.*, 2011; Chen *et al.*, 2008; Kutti, 1999; Lim and Hang, 2003). It is a conceptual as well as an analytical tool which envisages that a subject (individual or group) uses mediating artefacts to act upon an object to achieve an outcome.

Activity theory can be used in situations where one needs to make sense of actions in terms of their impact on the activity, the participants and their developmental potential, Engeström (2000, p.961). This approach is suitable in an 'area where artefacts are being developed for collaborative purposes' (Chen *et al.*, 2008 p.203). The use of activity theory in this research is to understand how information is used to make decisions by ad-hoc multi-agency teams of emergency responders.

Activity theory has an advantage over other methodological theories and frameworks such as situated action or improvisation. As Nardi (1996, p. 36) has pointed out, activity theory allows the context (activities) to be studied. However, unlike situated action, when using activity theory the reasons for being engaged in any activity (that is the motivation for doing any activity) can readily be identified (Nardi, 1996). Improvisation has been used as a methodological framework for unique situations such as emergencies (Mendonca & Wallace, 2007). Beech et al. (2010) however argued that improvisation can be *explored through the lens of activity theory.* With other action theories only linear sequences of work tasks can be

analysed whereas using Activity Theory, the socio-spatial dimension can be identified too (Nardi, 1996).

Activity theory 'considers human behaviour in terms of activity systems that are goal-directed' (Artemeva and Freedman, 2001, p.167). It originated from the work of a group of Soviet psychologists initiated by Lev Vygotsky in the 1920's and 1930's (Atemeva and Freedman, 2001; Engeström, 2000). Vygotsky's activity theory, also known as the first generation activity model, considers essentially a subject, an object and mediating artefacts. The subject acts upon the object using the mediating artefact as shown below in Figure 3.
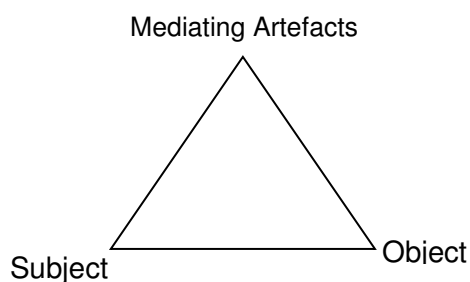
Mediating Artefacts

Subject   Object

Figure 3. Vygotsky's model of activity theory (1st Generation)

The unit of analysis is the activity. Activity can be further divided into actions and operations. As shown in Figure 4, the first layer is activity driven by an object-related motive. The second layer is an individual or group action driven by a conscious goal. An activity can be composed of one or several actions. The third layer is operations which constitute a routine process driven by conditions. When there is a change in the condition, operations can become an action. Thus there is a bi-directional relationship between levels.
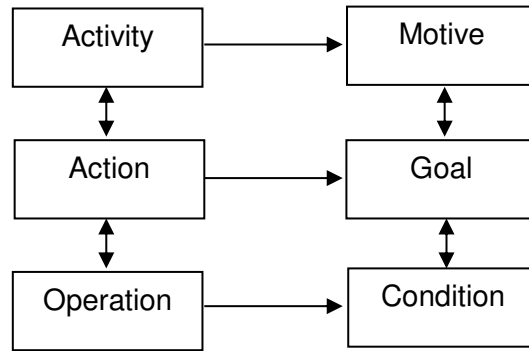
Figure 4. The hierarchical structure of activity (Kutti, 1999).

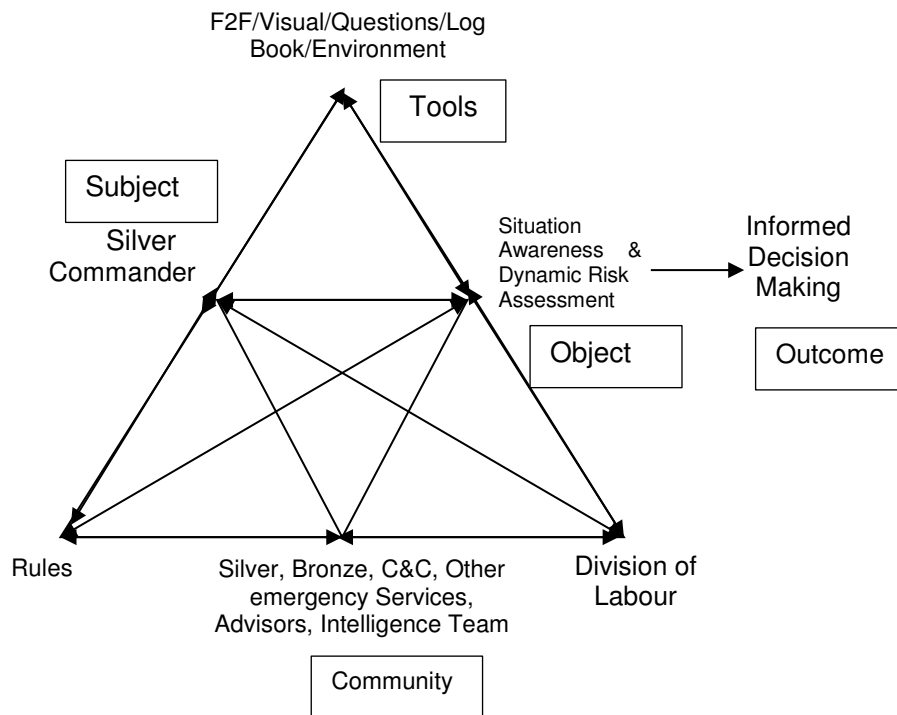For this research, Engeström's (1987) 2nd Generation activity model is used, as shown in Figure 5.

Figure 5 Activity system of Silver Commanders on arrival at the incident ground (adapted from Engeström (2000))

The model shows that an activity is object oriented and is *triply-mediated:*

- mediated by tools or artefacts such as face to face interaction, the log book, the environment, which provide the subject 'with the experience historically collected by his/her community' (Chen *et al.*, 2008)
- mediated by rules, regulations and social norms
- mediated by interpersonal relationships, roles (division of labour).

This underlying conceptualisation provides the foundation for the research design and data analysis to follow.

4.2 Research Design and Data Analysis

The research reported here aims to investigate in detail information use to make decisions in time constrained, uncertain and complex environments. To obtain such an in depth understanding, a qualitative research approach was used. Data was collected using semi-structured interviews and by observation.

Interview questions were developed using activity theory as a methodological framework. Guidelines for this process set by Mwanza (2001) and Karanasios et al. (2011) were followed. The focus for designing interview questions was on 'action' as it is the smallest unit of analysis which thus allows micro-analysis of context (Mishra *et al.*, 2010). The components of the activity system, for example rules and division of labour, were also used to design interview questions. For example, silver commanders were asked what social norms affected their decision making process; if they ever deviated from the rules and if so in what condition or what they did when the situation was unique and rules were not sufficient. This further helped in identifying tensions and contradictions which when acted upon lead to innovation (Engeström, 2001). For illustration, when asked if the respondent deviated from rules it was noted that:

> *One of the things that used to very often be a problem is the police officer attendance of fire and instincts are, if fire services are not there and somebody is trapped, police*

officer goes in, policy is you not going in. So they know that going in is not in the policy because they are not trained and the fire service are the expertise

As stated in the above quote, contradictions in the way silver commanders (the Subject) use the rule can be found and the underlying contradictions and tensions exposed serve to enhance our understanding of the relevant decision making processes.

A Critical Incident Technique (CIT) approach (Flanagan, 1954; McClelland, 1998) was also used to collect data. This is a procedure to 'obtain valid information regarding truly critical requirements for success in a specific assignment' (Flanagan, 1954, pp.328/9). As with Activity Theory, retrospective data is acceptable too in the CIT approach if the incident is recent and can be recalled by the subject. In CIT, as the interviewee should be allowed to do most of the talking in order to get an unbiased account, interviewees were asked to describe how they responded to a particular major incident. In this way, further insights about the decision processes were derived. Use of CIT is also found in other decision making research (e.g., Klein, 1998) and information systems research (Chen *et al.*, 2007; Sonnenwald and Pierce, 2000, Urquhart et al., 2003). To complement this data and for triangulation, government and practitioners' reports and other online documents were also studied.

Twenty semi-structured interviews were conducted with silver commanders. Potential respondents, tactical commanders who had an experience of managing major incident involving multi-agency work, were sent a description of the research and an interview request. Eight experienced silver commanders agreed to an interview. A further 12 respondents were contacted by a snowballing process. Seven respondents were from police departments (from England, Scotland and Northern Ireland), seven were from fire and rescue services and six were from the ambulance service. Out of these, nine respondents had more than 30 years' experience, seven respondents had 20-30 years of experience and 4 respondents had 6-18

years of experience. Interviews were mostly undertaken at the workplace. Interviews ranged from a minimum of 40 minutes to a maximum of 99. Permission was taken from interviewees to audio record the interviews and anonymity was maintained.

The interviews began by asking respondents about their background, how long they had been in the service, what their job title is and which department they work for. Respondents were then requested to talk about a recent incident that they had managed as a tactical commander in the response phase of a multi-agency incident which they remembered vividly. These varied from natural to man-made incidents including major fires, road and train accidents, floods, riots, chemical incidents and terrorism. Initial questions asked included details about the adequacy of data initially available, supply of further information, use of cues from the incident environment, information quality assurance, treatment of incomplete information, time pressure, gathering information from other team members and the perceived effectiveness of their own and others' decision making. As further, probing questions, questions relating to different components of the activity system were used. Though the respondents discussed their decision making process in the recovery stage too, for this research only the response phase was addressed. Interviews were transcribed verbatim and anonymised prior to analysis. NVivo, a software package for qualitative data analysis, was used for the coding. During the analysis phase, activity theory was again used as an analytical framework and activity models for different stages of emergency management were developed. Depending on the task, activity systems for four chronological stages were modelled viz.

- en-route (information collected whilst travelling to the incident scene and decisions made on the way);
- arriving at the incident scene (once the commander arrived at the scene, situation assessment was done);
- command and control of crew members (whereby decisions were made regarding resource allocation and crew members location of each individual agency)

- the silver meeting (in which silver commanders from different agencies come together to work on common aims and objectives).

This paper is based on the third stage, that is, the decision making involved after the silver commander reaches the incident ground. Thus decision making explored in this phase is at the individual level. A special focus was given to the tensions and contradictions among the components of the activity system to highlight instabilities in the system.

Using activity theory in this type of research is not without its limitations. It was sometimes difficult to distinguish between action and operation from the data collected using the interviews. Also, Silver Commanders did not normally talk about operations (actions not at conscious level). This may be because they may not reflect on something that is obvious for them. The best solution is to observe Silver Commanders in action in real time. Due to the sensitivity and the risk involved, observation of responding to a real time emergency by silver commanders was not possible. However, fortunately it was possible to employ an alternative approach to data acquisition, using observation of joint training and exercises involving the multi-agency emergency services (police, fire, ambulance, local authority, utilities and the army). A three full day tactical level training exercise was observed in the middle of data collection. 'Active looking, improving memory, informal interviewing [and] writing detailed field notes' (DeWalt & DeWalt, 2002, p. vii) were the activities conducted in the observation. Some participants in these training activities were interviewed after the observation which elaborated further why the participants chose particular decisions based upon the available information during the training sessions. Additionally, one full day table top exercise and three half-day joint exercises were observed near the end of the analysis phase, which helped in validating findings.

For the observation to be as unobtrusive as possible, Ambert et al. (1995) suggest that the observer should ensure that the situation is processed in a normal way. Thus in the training and exercise, the observer had minimum input to the process. Observations provided an opportunity to *grasp how participants communicated with each* other (Kawulich, 2005). Notes were taken on different scenarios and the conversations taking place. These notes were then coded and analysed. It is sometimes claimed that observations are not actual representation of the real environment and are based on the researcher's interest in the setting (Johnson & Sackett, 1998). However, observation provided a *richly detailed description* (Kawulich, 2005) of how commanders respond to an emergency and was further used to validate research findings effectively. As mentioned earlier, for triangulation, documentary analysis was also done.

In addition to using Activity Theory as an analytical framework, a grounded theory approach was also used for theory development. Data analysis involved open coding which was done for all transcribed interviews. It was followed by axial coding from which major themes emerged by a constant comparative approach (Strauss & Corbin, 1998). These themes were then categorised using the MindGenius software which led to the construction of a model for how information is used for individual decision making in time constrained, complex and uncertain environments. Thus, as Strauss and Corbin (1998) set out, the different stages of grounded theory, i.e. open coding, axial coding, selective coding (for developing categories) and theory building, were followed. It is worthwhile to note here that though tactical commanders were provided with tactical advisors and other commanders to aid in their decision making, decisions were mostly made on an individual basis.

5. Findings and Analysis

Although there are exceptions (e.g., Mendonça and Wallace, , 2007) , little information is available that provides an evidence- and practice-based foundation for design of DSS to support emergency decision making that recognises the importance of type 1 decision making.

A primary goal of the research reported here has been to gather, analyse and report such evidence.

Applying the Activity Theory analytical framework set out in section 4, we now present under a series of headings some typical examples of the insights and information gathered through analysis of the semi-structured interviews and observations that illustrate the following:

- The use of both type 1 and type 2 processing
- The importance of timeliness
- The dynamic nature of tasks
- The influence of time pressure
- The importance of public safety
- Concurrent influences on decision making
- Public expectations.

Taken as a set, these observations support a view about priorities for resilience research and DSS development which is argued in section 6.

Type 1 and Type 2 Decision Making

Depending upon context, both type 1 and type 2 modes of decision making are deployed. The excerpt below, by interviewee I16, shows that a silver commander had to make a decision within three seconds. Although it did not take a long time for the commander to decide, s/he did think of the impact the decision will have on other people.

I16: A man and a girl kidnapped, taken to a hotel room. It was necessary to raid all the rooms that was checked in around the same time as those kidnappers but then public prestige- ......so decision was made.... in 3 seconds

Emergency Responders may have done similar tasks before:

I17: because in those first ten minutes, you know what you need to do, you are so rehearsed at it

Pattern recognition is also used by silver commanders. If a commander is experienced, s/he may try to match the task to previous experience and then opt for a similar type of decision:

> *I5: Once we had established that resources were going to the scene, I was able to recognise that one of the key processes that would follow would be a casualty bureau*

The statement below suggests that due to incomplete information, a wider picture of what is happening may be not possible. Gut instinct may be used as commanders cannot wait for the complete information needed to obtain a holistic view of what is happening.

> *I7: Generally I say that the decisions is 80% right. It is better than no decision. So sometime, it comes down to gut instinct and say that my experience says this is the right thing to do in this situation. I think it depends on the nature of decisions that needs to be taken. If it is a decision that is not necessarily life threatening, then that would be a strategy to make.*

As seen from the above examples, silver commanders may not analyse, or at least fully analyse, options before making a decision. Several reasons are outlined above: lack of sufficient time; experience of the silver commander resulting in a quick judgment of the situation; or the lack of a complete picture due to which gut instinct needs to be used. These and other observations suggest a model of the practical working situation of silver commanders (Figure 6) which puts considerable emphasis on type 1 decision processing, in direct contradiction to the CMM (section 2) with its emphasis on the lobster pot and rational selection of courses of action. Given that there is a post-incident reporting process in place where deviations from the mandated style of approach can readily become apparent, this observation is not without significance.
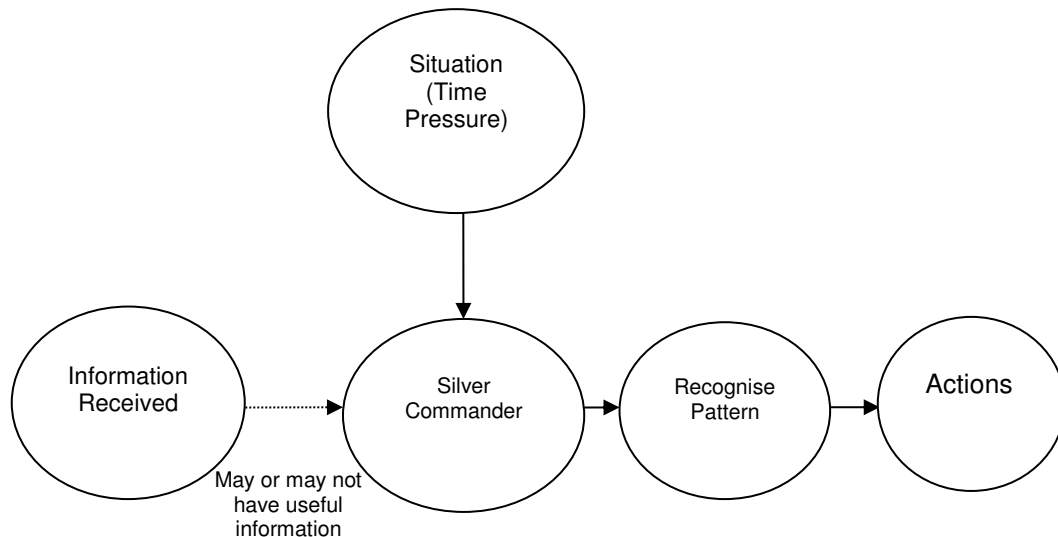
But the CMM is not ignored entirely. The excerpt below by I17 is consistent with the CMM. In this case, a silver commander analyses all the options and does the threat assessment of each option available.

> I17. I then have to do the other options and there's a gold standard there's a silver
>
> standard and a bronze standard and which way have I got the resources to staff that. So
>
> if I have got a no option, I do nothing I need to say, that will cause death, if I go for bronze
>
> it might cause death, if I go for silver it will stop it but in three hours I am going to have to
>
> put more resources in and if I go gold I may say if I go gold on this one it will cause that
>
> other problem here so I am going for the silver and I will staff that other problem in three
>
> hours and that is how I need to justify things.

However, as reflected in the statement by I5 it can be seen that commanders do not always follow the CMM for decision making.

> I5: We are concerned that not many people use it (CMM model) - they should be using it.
>
> It's there, it's for that purpose and we should consciously work through it.

As I4 and I7 illustrate below, a lobster pot model aids decision making as commanders become aware of possible options and then can choose the most suitable one.

> *I4: call it the lobster pot model. You know, when we sort of brainstorm what's going on and what our tactics might be, we get all sort of creative possibilities thrown our way. Somewhat- then the decisions come, we got to take those probably dozens of creative possibilities and refine them down to some feasible options that might work. And that we have to have resource to make them work. And from that then we have to say, OK, there are the three feasible options, knock one out so we are left with the choice. And that's how it is done ... we come out with one option that we go for.*

From the discussion above, it is clear that the type of decision making adopted by silver commanders can vary between type 1 and type 2. Moreover, as was stated by I17, both types can be used at the same time.

> *I17: No, I try and do that at the same time.*

Similarly, I19 expressed his/her view stating that the type of decision making can be either type 1 or type 2 depending on the situation.

> *I19: I think there's a bit of both but I think it depends, I mean there is a lot of pressure on you to make decisions sometimes and they have to be made quickly and sometimes you are going to make wrong decisions but I do think that people will act first and think afterwards, sometimes. It's difficult to say because it depends on what situation doesn't it?*

The statement by I6 below illustrates that to some extent type 2 decision making is used and then experience, knowledge and feeling kicks in. Thus, both types of thinking can be used in making decisions.

> *I6: There is a lot of information that you can't actually verify for yourself but going through a series of questions, you can actually drill it down, then I suppose you get it down to a judgement call. And, you will never find the situation where it is 100% correct or 100%*

wrong, there will be position between that based upon- your knowledge, your experience, your feelings for this type of incident, you will make decision one way or other.

According to the statement below by I14, due to experience, commanders are aware of the possible options so that analysing options can become a sub-conscious process or an operation; hence the formal CMM model may not be used but it is enacted.

I14: What's happening is because of your experience you are by passing the formal process but it is running sub-consciously behind everything else. So, you know, it's got what your legislation says, what are your options, you know, through that cycle, you are aware of what legislation says or you are seeking advice on it ….. It's a sub-programme that is running behind your decision making, you are actually doing that without consciously ticking the boxes and saying does that, does that, does that because actually you are running those things behind

Overall, several views are presented by the respondents on the type of decision making used. Some use type 2 (which is also encouraged by the policy makers), some use type 1 (if information is lacking or if the commander is more experienced) and some use a combination of type 1 and type 2 decision making.

In the statement below by I16, it can be seen that even after analysing the options for 5 to 10 minutes, the silver commander may make his/her decision intuitively.

I16: but I took that decision with probably 5 to 10 minutes to think about, the various options. Of course this is all happening so fast time because, not only we got the murder investigation, we got her being rapped, we got the guy who was the other man being separated and he didn't know that he is going to be killed- so trying to make decisions about all those sort of things at the same time. So stretched in terms of my thinking, but I said yes GO. You set them off and then you sat and say, I hope that was right- a right decision. And then you have to write what happened and justify why you went through.

<u>The importance of timeliness</u>

As stated by I7, timely and relevant information is important to ensure informed decisions are made.

> *I7: Getting the timely and relevant information and accurate information that will then give you that reliance.*

However, commanders do not wait for more information if time is not available. In situations where there was a lack of time, silver commanders were found to be making decisions without analysing options. Several situations can contribute to this outcome, some of which are outlined more specifically below.

<u>The dynamic nature of tasks</u>

The decision tasks to be undertaken, unlike most conventional textbook expositions, can develop rapidly and unexpectedly in a context where failing to act can often itself have significant consequences.

Adapt to an already happening task

Silver commanders can often find themselves taking over the role from the bronze commanders or taking responsibility when there is a change in shift. Because things may be moving fast, silver commanders may not have the time to analyse options but need to continue managing the incident.

> *I13: No, we act first, it will be a calculated but not a delayed response and that response will be adapted as more information comes in, it's a very organic process. The activity particularly with officers that come on at a later stage, the activity has already started you don't, it is very rare to stop everything and then start on with a different course of action. You will turn up and you will adapt the activities to fit your requirements.*

Need to react to fast moving situations

Also related to task dynamics is the lack of time to analyse options in fast moving situations. Because major incidents are fast moving, silver commanders are busy catching up with what is going on around them which makes it difficult for them to analyse any options at all.

> *I14: But broadly speaking, there is a formal QA process for formal intelligence. The problem with fast moving events is sometimes you are reacting to rapidly changing information that doesn't go through that process so you have to make a judgment call.*

Decisions being made all the time

Further, the sheer number of tasks may militate against analytical (type 2) processing. I20 illustrates that decisions are made all the time and in vast numbers; thus it is not possible to analyse options to make a decision.

> *I20: as I say the floods were slightly different because we had time to plan, time to think, in a big bang situation like the [Place] train crash you make decisions all the time and it is very difficult to one go through the normal rationale of the decision making process and then log your decisions because you are making so many decisions immediately on the hoof.*

The influence of time pressure

As well as rapidly unfolding dynamics of incidents, sometimes getting started straight away is itself an imperative. Commanders act first rather than analyse options also because of the possibility of improving the results. In this excerpt, rather than waiting and analysing options, it was found that it is better to act first and then improve the situation.

> *I19: it's easier to get the wheels in motion and cancel it than to wait for sort of 15 minutes until you find out what you have got and then think oh my god we are going to need everybody you know because you have just lost 15 minutes.*

The importance of public safety

In a similar way, sometimes the overwhelming influence of improving public safety mandates rapid action. This excerpt from I19 shows that under time pressure, the first decision that silver commanders take is related to public safety.

> *I19: Sometimes you have to make decisions good or bad, you know, a car is burning, someone has broken their leg, really we shouldn't be dragging them out but if we don't drag them out they are going to die. You know, so they are dragged out, it's like the easy thing first- afterwards thinking.*

Concurrent influences on decision making

Because there may be various sub-incidents happening concurrently in any major incident, the silver commander may be under pressure and may not have time to think over the options available to him/her, which prompts him/her towards acting first and then looking for justification.

> *I16: Of course this is all happening so fast time because, not only we got the murder investigation, we got her being rapped, we got the guy who was the other man being separated and he didn't know that he is going to be killed- so trying to make decisions about all those sort of things at the same time. So stretched in terms of my thinking, but I said yes GO. You set them off and then you sat and say, I hope that was right- a right decision. And then you have to write what happened and justify why you went through.*

This suggests that, under time pressure, silver commanders opt for type 1 decision making. However, as stated by I2, while silver commanders are indeed often under time pressure, unlike bronze commanders they do get some discretionary time which should be utilised to make timely and informed decisions. This excerpt indicates that time pressure may not always be a dominant issue for the silver commanders.

I2: You have got to be conscious of what discretionary time you have got for your decision because not all decisions have got to be made instantly, if they have to be they probably have been already at that level. So by definition at silver level you have got some discretionary time and you have got to be very conscious of what that is

Public Expectations

Silver commanders are supposed to make decisions by analysing options. However, due to the public expectations they may need to act fast, and there may not be enough time to analyse options. This can be seen from the excerpts by I8 below.

I8: but the moral pressure when you are in that situation is that you are quite different because the theory sounds fantastic but you have got pressures from members of the public. If you have got somebody whose family is in that premises, why aren't you doing anything, it's a dilemma for any incident commander whether it is a silver commander, bronze commander or whoever it is.

The availability of information

Lack of information and the way information eventually becomes available are important influences on how decision making is undertaken.

Lack of Information

On occasions, silver commanders find themselves with very little useful information. As a result, decisions made at that particular time may not be accurate which in turn may well impact the overall management of a major incident.

I10: We had no information about the potential hazards and that the gas which may explode- the way that goes because we don't have all the information, as the way the emergency responds. You have to make the decisions and there is an element of risk in responding to any incident as a basis of the more information you have the better you are going to assess that risk but at times you just don't have it.

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Information in bits

As is illustrated in Figure 7, information can often be provided to silver commanders in bits and pieces, as a result of which it is difficult for the commanders to analyse options in a type 2 way and thus decision making is limited to type 1.

I2: decision is made based on all the little fragments of information that come in from you know what you can see, what you hear over the radio channels, discussions with people who have been at the various sectors and you have the occasional operations meetings to see how well it is going. Knowledge then of the type of structure and type of chemicals and all of this, it comes in lots and lots of little bits and I don't think, and this is where it comes back to the intuitive decision making kind of making situations I don't think there ever comes a point where you have listed all these things and scored them and done it objectively.
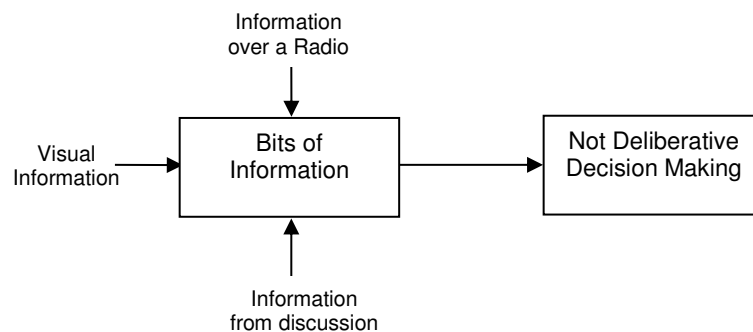

Figure 7. Information coming in bits

Under time pressure, silver commanders act first and then with the availability of more information they try to adapt and modify their actions.

I13: No, we act first, it will be a calculated but not a delayed response and that response will be adapted as more information, it's a very organic process.

I18: I might think afterwards, did I make the right decision? And, if I thought of something later, I would try and see if I could implement what I have made if we can make any changes that in this time, had I forgot something or I did it this way, I'm now thinking about it ten minutes later, it might have been better doing it another way. If I

have got chance to still change it I will try and make another decision and alter the course

of that decision, but if I can't then that was the decision I made at that point and there is

no point in doing anything any different. I have got to move on and say, what is the next

decision I have got to make

Changing the course of the decision made

Because information comes in bits, silver commanders make decisions with the information

available at that time. With more information, they change their decisions if appropriate, see

Figure 8. Such information may come through interaction with other team members or

possibly through reflection about the pattern of events developing and earlier decisions and

the application of relevant protocols.

I20: you make a decision, you re-evaluate what you are doing and then you change, you

know you either accept it and move on or you change that decision and move in a

different way. I think all our commanders that would be potential bronze silver or gold
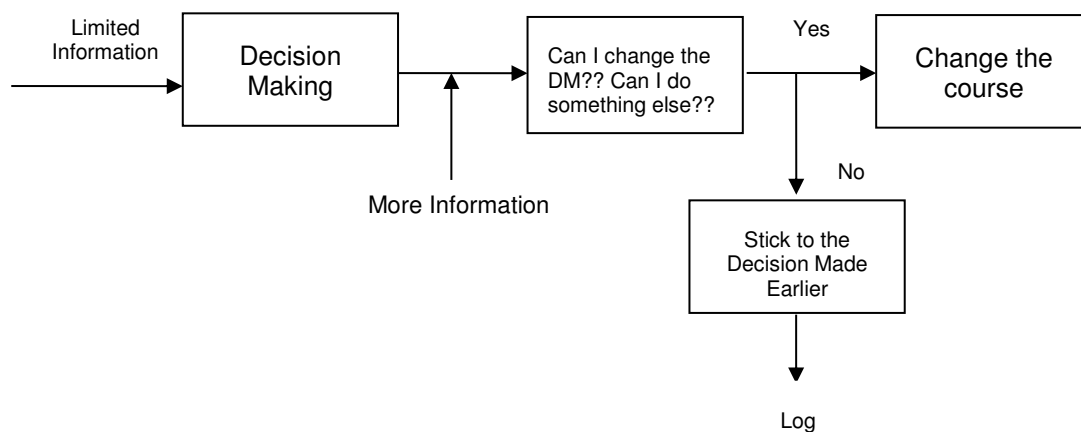
commanders would follow that rule

Figure 8 Changing the course of action with more information

Overall, this set of accounts suggests a lack of information which in turn hinders decision

making. Moreover because information comes in bits, it is difficult for the silver commanders to

wait for complete information to come, thus decisions are made with incomplete information,

which will in general encourage the use of type 1 decision making .

From the excerpts below it can be stated that use of information is not only to make decision but also to justify decisions that are already made. This is especially applicable to the situations where decision making is type 1, as decisions are made on instinct or gut feeling.

I14: You will make an intuitive decision and then in retrospect you will justify that decision ... because I think it's hard to actually show the input and thought process followed by decision. It is easy to make the decision and then show the reasons for it.

I5: If you have got to act quickly then people do take chances.... sure, they will say that they made a dynamic risk assessment. They will say that everything was good and you know that there is an element, it's not lying is it- it is justifying, justifying decisions that have already been made

From the verbatim quotes above it was found that silver commanders may seek for information after decisions are made. This can be added to Figure 6 and can be remodelled as shown in Figure 9.
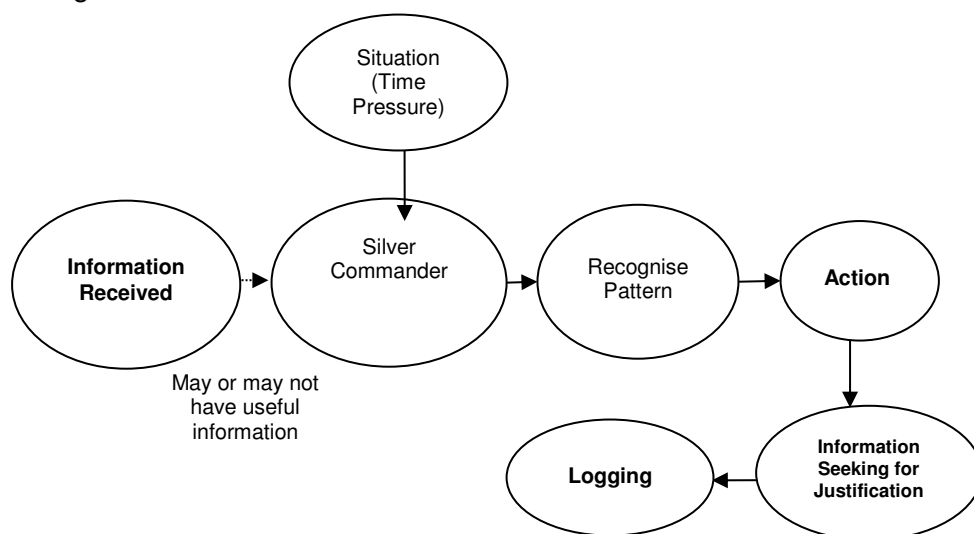
Figure 9. Decision Making Process of Silver Commanders

Combining Figures 6 - 9 suggests a general model of information use for decision making in time constrained, uncertain and complex environments of the form shown in Figure 10.
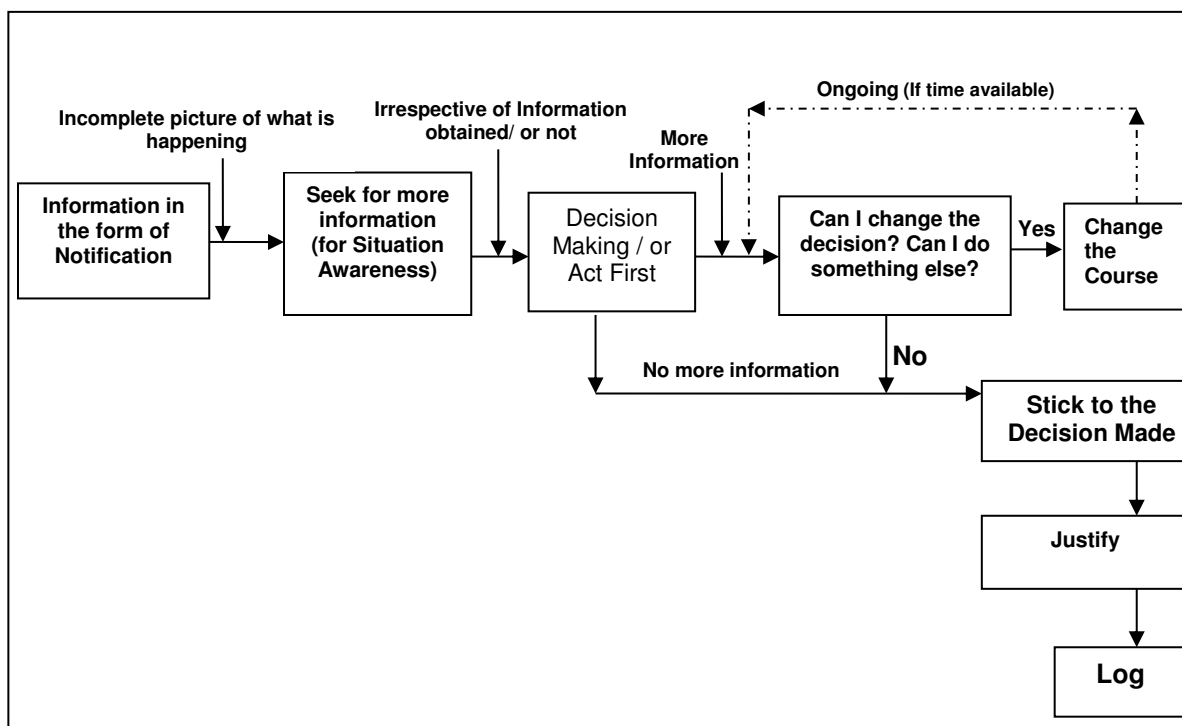

Figure 10 Information use in time constrained, uncertain and complex decision environments

The implications of this catalogue of observations about emergency responders' decision processes and the relationship between information, decision support, decision making and resilience will be addressed in the next section.

6. Discussion

Silver commanders within the emergency response environment work at the heart of the system that aims to deliver a resilient response to significant emergencies. They face a particular, but not necessarily unique, set of circumstances in that they can well be undertaking their decision making under pressure of time, in a context of high complexity and uncertainty where there are potentially very high stakes.

Anecdotal and other evidence, now supported by analysis of the interviews and periods of observation on which this paper is built, suggest that, although silver commanders operate in principle within the structuring framework of the CMM which encourages rational, type 2 decision making, in practice significant elements of their decision behaviour follow something much closer to a type 1 route. This occurs despite the fact that there is a mandatory system of post-incident reporting where actions may be evaluated against the background of the CMM and the lobster pot model.

Why this occurs appears to derive from a series of potentially interacting contextual issues that influence (parts of) the overall decision making process. These include issues:

- directly relevant to the decision [complexity, uncertainty of outcome, ambiguity in relation to outcomes and underlying values]
- defined by the urgency of the situations involved [decisions cannot always wait for full information to be available; some decisions must be almost instantaneous]
- relating to the dynamic and sequential nature of some of the decisions [decision strategies often need to be and can be amended in the light of developments and/or newly acquired information]
- arising from the often paramount importance of public safety influencing choices not only as a direct result of their importance to the decision concerned but also deriving from the ethos of the relevant emergency services
- linked to overload in that often many sub-issues have to be processed simultaneously in the face of large volumes of information arriving in real time and where that information may not always be relevant or even accurate
- where there will be a public expectation towards visible action rather than inaction

In addition to these factors, another central influence is the level of experience of the silver commander with the type of incident concerned, which may not always be strongly correlated with his/her overall level of experience. There can also, of course, be influences on decision making arising purely from individual differences in cognitive style.

Whatever the underlying set of causes, the paper has provided strong corroborating evidence to the existing knowledge base, that silver commanders do not consistently use type 2 decision processing, but employ significant amounts of type 1 within an overall approach that employs both.

The extent to which this reality of decision behaviour by people facing complex, uncertain and time constrained decisions is reflected in the decision support offered to them is, as yet, limited. However, as the evidence in this paper suggests, despite important recent advances, there are still important gaps in our understanding of what decision processes are used by whom, where, when and why within emergency contexts. Without a full understanding of the answers to these questions the resilience of societal response to emergencies is inevitably constrained.

Nevertheless, constrained is not the same as denied. Work such as that of Perry *et al.* (2012) is valuably exploring how variations in the *way* in which information is presented may be tuned to the particular needs of decision makers with different levels of expertise. Arguably as important is to understand better what drives the choice of different approaches (type 1, type 2, mixed types 1 and 2, RPDM).

Here we have outlined a number of influences that primarily revolve around the nature and context of the decision. But ever-present in the background is the question of expertise or experience, how it affects decision making style and how that in turn influences information needs and information presentation. This type of decision making, which emerges through recognition of a pattern, is intuitive and develops due to the regularity of operating in a particular environment (Kahneman & Klein, 2009) and experience. Thompson *et al.* (2004) showed in their research that information seeking is generally associated with inexperienced people rather than experts. This also suggests that expert decision makers may not always

seek out information, as pattern recognition fills the information gaps. When people have sufficient knowledge and experience, they are able to reject false information faster and more effectively (Perry *et al.*, 2012).

In our view, there is an important and rewarding research agenda to be pursued in the emergency response and resilience contexts that seeks to clarify understanding of the drivers to different types of decision process and identifies what form(s) of decision support most effectively contribute to informed decision making in all the various circumstances of decision type and context and recognising the individuality of the decision maker. At present, a type 2 style of support dominates. The evidence of this paper suggests that support to a type 1 style of thinking needs consideration too. This does not, of course, mean unquestioning support. Much of the recent progress in decision research has been linked to the analysis of heuristics and biases in unaided human decision making and an important role in type 1 DSS must surely be to help the decision maker question his/her intuitions as much as it is simply to support and inform those intuitions. A judicious but context-sensitive mix of type 1 and type 2 styles seems, on the basis of the evidence presented here, to be the most appropriate direction.

Acknowledgements

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