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## Information seeking, use and decision making

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## **Abstract**

In this paper we explore the three areas: decision making and information seeking; the relationship between information seeking and uncertainty; and the role of expertise in influencing information use. This is undertaken in the context of qualitative study into decision making in the initial stages of emergency response to major incidents. The research took an interpretive approach in which Activity Theory is used as a methodological and analytical framework. The research provides further evidence that the context of the activity and individual differences influence choice of decision mode and associated information behaviour. We also established that information is often not used to resolve uncertainty in decision making and indeed information is often sought and used after the decision is made to justify the decision. Finally we point to the significance of both expertise and confidence in understanding information behaviour. The contribution of the research to existing theoretical frameworks is discussed and a modified version of Wilson's problem solving model is proposed.

## **1. Introduction**

The context in which information behaviour (IB) takes place is of growing interest to information researchers for a number of reasons. Context is increasingly seen as significantly influencing information behaviour (Fisher, Landry, & Naumer, 2007) and the generalisation of findings from research which is undertaken within the limited context of the information behaviour within academia is increasingly seen as problematic (Wilson, 2008). Contexts in which work information contexts are static and where information tasks or activities are relatively simple are not seen as representative. As a result, a body of work has emerged over the last decade which explores information behaviour in alternative contexts (Byström & Hansen, 2005; Byström & Järvelin, 1995; Ellis & Haugan, 1997), particularly work environments. A key question for these researchers is; when we study information

behaviour in work environments can we generate new knowledge which extends, challenges or refutes existing IB models and assumptions?

In this paper we explore this question in relation to three areas: decision making and information seeking; the relationship between information seeking and uncertainty; the role of expertise in influencing information use. We do this by focusing on a context and tasks which are dynamic, complex, and uncertain and time pressured: the initial stages of emergency response to major incidents or disasters. This context is interesting because it provides an environment in which information phenomena are 'writ large' and the individuals involved are involved in particularly information intensive activities (Folb, Detlefsen, Quinn, Barron, & Trauth, 2010). It is also highly relevant to practice and to research, as fully understanding information use in this context has proved to be an intractable problem.

This paper proceeds as follows: in the next section literature on information behaviour in relation to decision making, expertise and uncertainty is reviewed. This is followed by a description of the methodology used in this research project highlighting Activity Theory as a methodological and analytical framework. The following findings and discussion section illuminates the following research questions. Are decision modes which don't conform to traditional IB approaches used? Does expertise moderate information seeking and decision making? Is information sought and used primarily to resolve uncertainty? This is then followed by a conclusion which highlights the key findings from the research.

## **2. Literature Review**

The purpose of this literature review is threefold; to provide a brief review of decision making, highlighting the models used within IB research; to review relevant literature related to the influence of expertise; to explore the issue of information use and uncertainty.

### **2.1 Modes of Decision Making**

Berryman (2008) notes that information research has relied upon 'rational decision theory' to understand human decision making. In this approach effective decision making is seen as being preceded by and inextricably linked to the seeking and use of information (c.f., Allen, 2011) to make reflective, evidence based decisions. However, Berryman was also one of the first IB researchers to identify new developments in decision science pointing to Naturalistic Decision Making (NDM) as an alternative model. Klein (2008) and colleagues (c.f., Klein, Orasanu, Calderwood, & Zsombok, 2003) developed the NDM model indicating that, in contrast to the rational decision model, experts made high quality decisions drawing upon a holistic process involving situation recognition and pattern matching to memory structures to make rapid choices (Endsley, 1997). Despite Berryman's (2008) suggestions that information science look to this approach, very few researchers have heeded her suggestion. One of the few information science studies to utilize NDM was MacDonald, Bath, and Booth (2008; 2011) in analysis of decision making and information use in the health sector. They note that when information was absent "...participants satisfied. They... made decisions recognizing that they did not have all of the information they needed" (MacDonald et al., 2008: 31).

A stream of recent research within decision making has focused on the dual processing debate. Within this debate two approaches, reflecting different modes of thinking, have been identified as driving decision making. These have been labelled in differing ways as experiential and rational, intuitive and deliberative, reflexive and reflective, intuitive and analytic, system 1 and system 2 (Evans, 2008), type 1 and type 2 (Stanovich, West, & Toplak, 2011). While the labels vary, the sets of terms share the same broad characteristics. The first set of terms refers to decisions which draw upon *instinctive knowing* such as a "hunch" or "gut feeling" (Hammond, 2010) or tacit knowledge and where information is processed in a 'non-conscious holistic' manner (Sinclair, 2010). In this mode of decision making, 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. The second approach is described as a formal process which is conscious and sequential and involves analysis before reaching a decision (Kahneman & Lovallo, 1993). In this mode, the optimum decision is chosen based on the available information. However, due to the bounded rationality of humans, sometimes in this method people opt towards satisficing (Simon, 1955), rather than optimising decision.

Though the neutral term is system 1 and system 2 (Evans, 2008), the term type 1 and type 2 is often preferred (Stanovich et al., 2011). In this paper we refer to these as type 1 and type 2 forms of thinking. The key issue within this type 1 and type 2 debate which is now receiving some recognition within the information science community relates to the relationship between the two modes of thinking in decision making and its implication for IB. 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). Recent work has, however, suggested that, rather than being incommensurable and incompatible dualities which work in an opposing form, type one and type two approaches may form complementary dualisms. Allen (2011), drawing upon dual-processing theory, proposed five different modes of information seeking, 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).

While this body of research indicates that context influences decision mode and corresponding information behaviour there is also a tradition of research which suggests that individual differences play a significant role in the decision mode used by decision makers irrespective of context. One aspect of difference which is particularly seen as influencing behaviour is expertise.

## **2.2 Expertise, information and decision making**

The role of expertise in influencing how decision making is undertaken has been widely studied particularly in the context of NDM. Greitzer et al. (2010) states 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 need to process the information and use a rule base approach (if – then) . They suggest that this not only more accurately describes decision making processes, but, importantly, also provides a more effective basis for support of decision making. Establishing what characterises “an expert”, how an expert functions and how experts and non-experts differ in their decision making is all part of the training challenge faced by many organisations. One way to approach expert/non-expert differences is to understand cognitive skill development and studies in this area have investigated factors such as differences in information representation (Hutton and Klein, 1999); attention to relevant information (Randel et al, 1996); chunking – the ability to condense information into meaningful chunks (Means et al, 1993); use of pattern matching (Klein, 1998) and the mental organisation of domain knowledge (Glaser, 1987).

The role of intuition in expertise-based decisions has also been studied (e.g., Salas et al., 2010) – both its function and its development – as have broader issues relating to problem solving method and cognitive strategy (Elliott, 2005). Also explored are links between expertise and confidence. For example, Shanteau (1988) found that top decision makers in a number of sectors share psychological characteristics such as perceptiveness, communication skills, self-confidence, and creativity under stress. Especially in areas where decision making is time-pressured, subject to uncertainty, complex and involves potentially serious consequences, to understand and respond to the interaction between expertise, decision making style and information behaviour is clearly important.

Overall, a number of facets of expertise appear to be common across domains, but in general understanding is as yet far from complete and deeper knowledge at the cognitive

level holds the potential to allow more effective interface design and information provision appropriate to the particular individual decision maker and the decisional context.

In the field of information behaviour Ju (2007) found that task combined with type of expertise played a significant role in users' interactions with information interfaces. White, Dumais, & Teevan (2009) stated that the information searching and seeking patterns of experts are significantly different from non-experts. It has also been found that experienced people will have many different options (Sonnenwald, 1999). Their experience and personal knowledge influences the choice of information channels (Ellis & Haugan, 1997). Experience often helps when decision makers encounter negative affective information (Bhattacharjee & Moreno, 2002).

Analysing previous experience can lead to isomorphism. According to Kirkwood (1999), 'if circumstances are duplicated, the consequences will be the same'. Thus, for an experienced decision maker if the situation resembles a past situation, the actions or decisions to be made will be dependent on past experience. The NDM approach argues experience helps decision makers to make a decision, as it acts as a source of information (e.g. G. Klein, 1998) by recognizing patterns to fill information gaps. Finkelstein, Whitehead and Campbell (2008), however, warned that people 'are at risk of making poor decisions when they have enough experience to believe' [that they are right] (p.27). Weick (1993) too indicated that under time pressure, people 'regress to their most habituated ways of responding' indicating that people rely more on their past experience. In the Tenerife air disaster, Weick (1990) delineated how past experience of an aircraft pilot led to an assumption which resulted in a catastrophe. Court (1997) in his research on engineers developing new products showed that products were not developed considering the new information available but were based on information gained from experience, indicating that experienced people may not use new information or give it sufficient weight. Radecki and Jaccard (1995) added further that when people feel they are more knowledgeable, they do not search for information systematically and 'may be more likely to use simplistic decision rules'. It seems that while expertise is a



key influence on decision making and fundamentally affects information seeking and use, there are many as yet not fully integrated lines of investigation and its influence on information behaviours remains opaque.

### **2.3 Information use and uncertainty**

A third important, but under-researched area is the relationship between information use and uncertainty. Information behaviour research tends to be dominated by inquiry into information needs and seeking and less attention has been given to information use (Kari, 2007; O'Farrill, 2008; Wilson, 1997). Information use is identified to be an action that takes place after the search for information has taken place, or information is acquired or received.

Uncertainty is often linked with task complexity (Daft, Sormunen, & Parks, 1988; Tihamiyu, 1992). Alchian (1950) stated that uncertainty arises from the 'human inability to solve complex problems'. Thus, if the task is complex then uncertainty is higher. Kuhlthau (1993) in her Information Search Process (ISP) model, classified task into different stages based on the level of uncertainty viz.,

- initiation ('awareness of need of knowledge')
- selection ('general topic defined')
- exploration ('information encountered albeit not consistent')
- formulation ('uncertainty diminishes and confidence begins to increase')
- collection ('effective interaction between user and system') and
- presentation ('searching task is complete')

"Complex task" in information science research is equivalent to task uncertainty (Vakkari, 1998). A positive relation exists between the two, i.e. if the environment is uncertain then the task will be complex (Culnan, 1983).

Uncertainty is also associated with the type of source accessed. For example, Sawyerr (1993) in the investigation of perception of environmental uncertainty and environmental scanning behaviour (of information) identified that with greater environmental uncertainty

there was an increase in frequency of scanning i.e. increase in information seeking. Daft and Lengel (1986) argued that with a high level of perceived strategic uncertainty, the use of personal (as opposed to impersonal) and external (as opposed to internal) sources of information is high. Chowdhury et al. (2011) identified that when the internet is used as a source, uncertainty may not decrease due to the vast amount of information available on the web, indicating that information overload can be a cause of uncertainty. They also identified that unfamiliarity with the source can be a cause of uncertainty in seeking information. Thus different types of source, and competencies in using these sources, can have different impacts on the reduction of uncertainty.

As underscored by Allen (2011, p.2169) in information practice research, uncertainty is an ‘activator of deliberative goal directed information seeking behaviour’, but uncertainty as an overall context has not been explored in depth. It has only featured in a few studies in the information science literature, and in particular in the context of environmental scanning (Benczúr, 2005; Choo, 2001).

One of the most influential models of information use and uncertainty is due to (Wilson, 1999). Wilson linked information use with problem solving and resolution of uncertainty (see Figure 1).

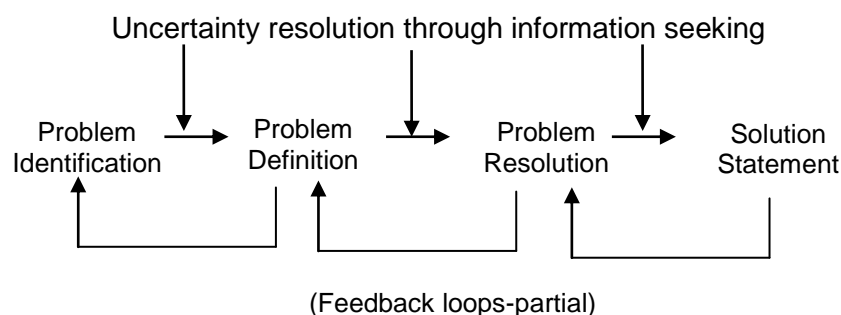


Figure 1: Problem solving model by (Wilson, 1999)

Wilson categorised problem solving into different stages such as problem identification (identifying the types of problem); problem definition (finding out the nature of the problem); problem resolution (how do I find the answer to my problem?) and finally solution statement (presenting an answer to the problem). He further argued that uncertainty can be present until the final stage but decreases in each stage (Wilson, 1999). This type of problem solving model is mostly a rational (Type 2) style of decision making (Allen, 2011; Savolainen, 2006) and is similar to the lobster pot decision making model (see figure 2), where after each step options are narrowed down and hence uncertainty is reduced and, once the final option is chosen, the task is completed.

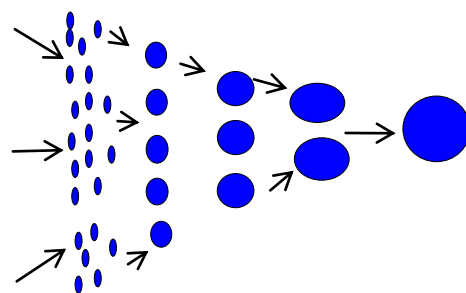


Figure 2. Lobster Pot Decision Making Model (Adair, 2007)

Thus uncertainty reduction is often considered as the rational model in the information behaviour research, the rationale for information seeking and use. However as illustrated by the work of Fu and Sim (2006) uncertainty in information quality and uncertainty due to information overload are also not without relevance. The wide and growing range of behavioural research has established that, in reality, much decision making in circumstances where the complexity of the situation exposes man as a 'limited capacity information processor' (e.g., (Newell & Simon, 1972)) falls back on heuristic procedures and/or perceptions of previous choices.

An interesting question, therefore, is, is it correct to see uncertainty and the resolution of uncertainty as the prime motivator for information seeking and use of information? ' Even if it is, it still remains that in many of the application contexts on which the current research focuses, the way that the acquired information will be used will not necessarily be consistent with rational, type 2 modes of decision making. If that is the case, then a further question is whether the ways information is provided to support such decisions should acknowledge that fact and perhaps tailor information provision in ways that are better suited to type 1 modes of operation.

In conclusion in each of the three areas outlined in this literature review we have identified that there is a need for further research and have identified some key research questions. In the following section we outline the methodology used to explore these questions.

### **3. Methodology**

The context selected for this project was the information behaviour of Category One Emergency Services Personnel involved in decision making in response to major man made or natural incidents (from a terrorist attack through to flooding) in the UK. Category One responders are the 'blue light' services such as police forces, fire and rescue services, and ambulance services, along with local authority and environment agencies. In the UK, incident commanders were at the time of the fieldwork for this research classified into a hierarchy of gold, silver and bronze depending upon the role that they play. Gold Commanders take a strategic role and often manage from a location remote from the incident and liaise with a number of Silver commanders. Silver commanders manage from the periphery of the incident overseeing a number of Bronze commanders. Bronze commanders work at the incident site managing a crew of personnel from a particular emergency service. Silver commanders, who are the coordinators at the incident were selected for the study as they need to make numerous tactical decisions in complex,

uncertain, dynamic and time constrained environments (Comfort, Sungu, Johnson, & Dunn, 2001).

The research was further narrowed to focus on the response phase. Emergency management, as shown in Figure 3, is categorised by the Federal Emergency Management Agency (FEMA) into four different phases, mitigation, preparedness, response and recovery. In the response phase immediate assistance is provided and efforts are made to minimise the hazards created by the disaster in terms of management of evacuation, emergency relief, search and rescue. This was selected as the most critical, complex, dynamic and transparent phase in which emergency decisions have to be made (Comfort et al., 2001; Haddow, Bullock, & Coppola, 2008).



Figure 3. Circular relation between phases of emergency management (NEHRP)

Within this research project, Activity Theory has been used as the overarching framework for understanding and exploring information management (Chen, Sharman, Chakravarti, Rao, & Upadhyaya, 2008; Kutti, 1999; Lim & Hang, 2003; Wilson, 2006). It has also been used by many researchers to study information behaviour in similar emergency environments (Allen, 2011; Allen, Karanasios, & Slavova, 2011; Chen et al., 2008; Henggeler Antunes, Almeida, Lopes, & Clímaco, 1994) and is particularly helpful in situations where one needs to make sense of actions in terms of their impact on the activity, on participants and on their

developmental potential Engeström (2000). Activity Theory ‘considers human behaviour in terms of activity systems, that is goal-directed’ (Artemeva & Freedman, 2001). Its origin can be traced to the work of a group of Soviet psychologists initiated by Lev Vygotsky in the 1920’s and 1930’s (Artemeva & Freedman, 2001; Yrjö Engeström, 2001). In order to obtain in depth understanding and “thick description”, a qualitative research approach is adopted.

In Activity Theory, the unit of analysis is activity. Activity can be further divided into actions and operations, leading to a three-level model 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, 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 these levels.

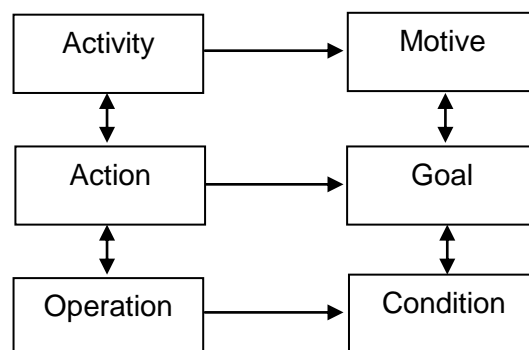


Figure 4. The hierarchical structure of activity (Leont'ev, 1981)

The model illustrates that an activity is object oriented and is *triply-mediated* (Spasser, 2002:93).

- mediated by tools or artefacts, which provide the subject ‘with the experience historically collected by his/her community’ (Chen et al., 2008:207). In an activity system, mediating artefacts may be internal such as signs or language, or external physical tools.
- mediated by rules and regulations
- mediated by interpersonal relationships, roles (division of labour)

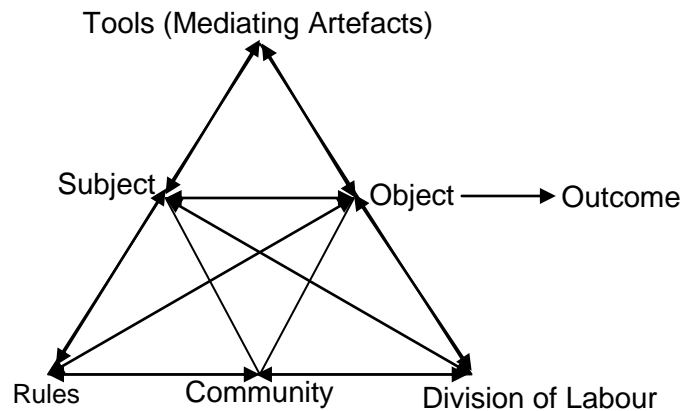


Figure 5. 2<sup>nd</sup> Generation Activity Theory as represented by Engeström (1987)

In the research reported in this paper, activities were analysed, using Activity Theory, on a temporal basis, as shown in Figure 6.

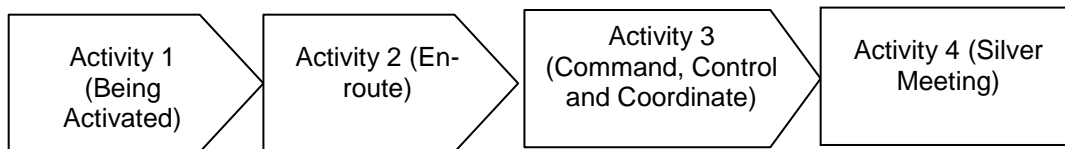


Figure 6. Chronological stages of a Silver Commander in managing a major incident

Once the Silver Commander reaches the incident ground (the location where the incident has occurred), the major task is to command, control and coordinate. This activity can be further divided into different actions within an activity system for each action, as shown in Figure 7.

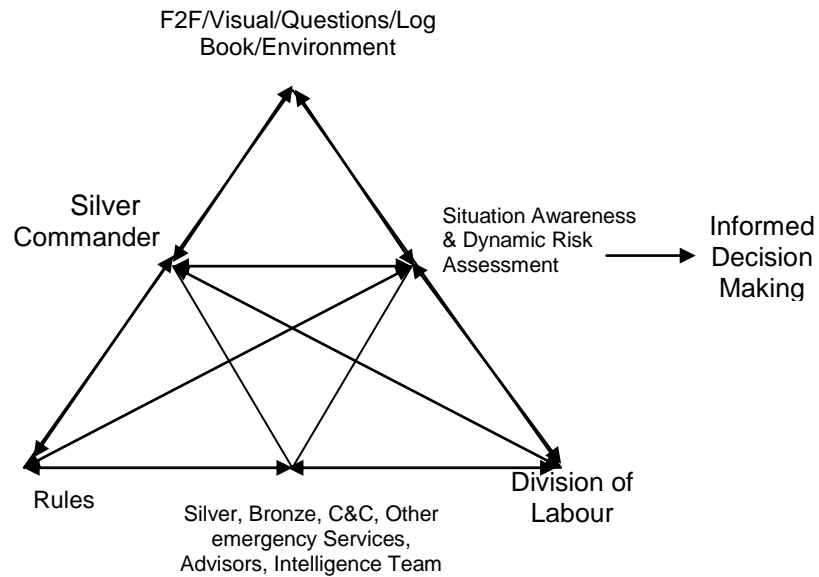


Figure 7. Activity system of a Silver Commander on arrival at the incident ground

Working within this analytical framework, data was collected using semi-structured interviews, having used Activity Theory to develop the interview questions themselves (Barriball & While, 1994). Twenty interviews with Silver commanders who had experience of the management of a number of major incidents were undertaken, using the Critical Incident Technique (CIT). CIT is a procedure to 'obtain valid information regarding truly critical requirements for success in a specific assignment' (Flanagan, 1954 :328-329) and has been used in many studies, including as a data collection tool in information science (Sonnenwald & Pierce, 2000; Urquhart et al., 2003) and decision making (Klein, Calderwood, & MacGregor, 1989).

In addition to the interviews more insight about the actual way in which Silver commanders engage themselves, at multi-agency level, was gathered through observation of exercises. Due to the sensitivity and the risk involved, observation of real time emergency management was not possible. However, fortunately it was possible to observe joint training and exercises



of the multi-agency emergency services (police, fire, ambulance, local authority, and utility services, army). A three full day tactical level training exercise was observed, also a one full day table top exercise and three half-day joint exercises. During observation, notes were taken and when permission was granted, audio and video recording was also undertaken.

Coding of the collected information was done using advanced qualitative data analysis techniques employing an inductive framework. Open coding was done by reading word-by-word the transcript and using the constant comparative method suggested by Strauss (1987). Categories were also created based on the components of activity systems (such as rules, tools, division of labour). Contradictions, an essential part of an activity system, were investigated and coded. Whenever possible, categories were grouped using *in vivo* coding (code names derived from the interviewees' language) to reflect the language used in practice. Once the open coding was done, depending on the relationship found between different categories, axial coding (connection between categories) was done which aided in finding the major themes (Strauss, 1987).

To complement the data collection and for triangulation, government and practitioners' reports and other documents available online were also studied.

#### **4. Findings and discussion**

In the following section findings from the research are presented and discussed in relation to the three issues of: types of decision making, the resolution of uncertainty, and the moderating influence of expertise.

##### **4.1 Modes of Decision Making**

During the research it became clear that crew commanders did perceive a need to engage in Type 2 decision making and in many circumstances made decisions based on a deliberative, analytical and conscious process. They described an information rich process which required reflection. One respondent, for example, recognized this when s/he stated:

*I'll like to try and think, I think that I look at alternatives, everybody wants a snap decision but I want time, I don't want to shoot from the hip, I want time to think*

Nonetheless, it was clear that while commanders did engage in Type 2 approaches, they often moderated this process by also using Type 1 decision making:

*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*

The excerpt presented below also suggests that even when information is not sufficient to build situation awareness, people can use their experience to fill the gap. An experienced decision maker may often “know” how the incident will transpire, which will subsequently enable them to make swifter decisions.

*if you are too experienced, you can try to fill the gaps with I know what is going to happen here- you know in your thinking. This is the way it is going to turn out. And I have spent years in trying to find that myself about, I know how they are going to play it or this is what this is going to do..... I have been here before therefore this is what will happen. I had been through this before- this is easy*

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 (Finkelstein et al., 2008). Thus experience is found to be an influential factor that affects the decision making mode.

The use of an approach which blended type one and type two was explicitly linked by respondents to lack of time to engage type two decision making. One respondent noted:

*... 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*

Time sensitivity added to the complexity of the situation and was identified by a number of respondents as a reason why they engaged in type one approaches.

*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*

Others noted the high value/impact of the decision context allied to time sensitivity as a key factor driving mode one approaches:

*... 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. 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- afterwards thinking*

In this context it was argued that it is better to make any decision rather than no decision at all.

*Generally I say that the decision 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*

However, as time sensitivity and complexity increased they noted that they would be more likely to engage in Type 1 approaches:

*In a big bang situation like the 'Name' train crash, you make decisions all the time and it is very difficult to one to 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*

This statement below suggests Silver commanders, with regular practice and experience, may have integrated the rules into their behaviour. Although people are often making analytical decisions non-deliberatively, they may be using the heuristics which come with experience (Evans, 2011). Evans (2011) further stated that type 2 thinking can also be faster as '...with experience people may develop useful heuristics which are quick and simple to process' .

*... you come with all these ideas, you refine them and come with 2 out of 5 and – you say that it could be time consuming process, but it's not, that can happen very quickly*

From the description above, it can be concluded that the combination of Type 1 and Type 2 decision making may be used in complex, uncertain, dynamic and time constrained environments. Silver commanders are encouraged to use Type 2 decision making, however, in practice they do knowingly engage in Type 1 decision making. The findings also suggest that although Silver commanders may have some discretionary time available, they are inclined towards the combination of Type 1 and Type 2 decision making, as Evans (above) stated. In the information science literature, information seeking is often identified to be an analytical and conscious activity in which, once the user identifies the need for information, they start searching for and selecting it based on relevance (Savolainen, 2006). Allen (2011) however, has argued that people may not always analyse options and may follow different modes of decision making. Consistent with Allen's research (2011), in this research, it was found that in complex, uncertain, dynamic and time constrained situations,

while making decisions, decision makers may not seek information and may rely on their experience and inherited mental models.

#### **4.2 The moderating influence of expertise**

The role of expertise in moderating decision behavior, both directly and indirectly through factors such as confidence, is complex and only partly understood. Although contrasting views are identified in the literature on expert decision making, several researchers (Court, 1997; Rennie & Gibbins, 1993; Ullman, 1992) suggest that experts make better decisions and this is more pronounced in time critical and complex situations (Klein, 1998). This research finding also indicates that people rely on their past experience, and base their present decisions on the knowledge gained from past experience which helps in complex, uncertain, dynamic and time constrained environments.

The findings of the study reported here add something to the relevant body of knowledge. In this research, use of Type one modes of thinking was found to be closely associated with experience. Respondents noted the link between experience gained by training and Type 1 decision making:

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

Relatedly, pattern recognition was also found to be used in making decisions by Silver commanders. If a Silver commander is experienced then s/he might try to match the task to previous tasks and then opt for a similar type of decision.

*What's happening is because of your experience you are bypassing 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*

It was clear that experienced commanders were more likely to use Type 1 approaches to decision making and to make less use of information before a decision was made. Over and on top of this, a further influential factor on the decision making approach adopted appeared to be the confidence of the decision maker. The data indicated that higher levels of expertise will *in certain circumstances* lead to greater confidence which in turn encourages Type 1 decision making. However, in some circumstances it seems that even a generally expert decision maker will, perhaps because of the exact type of the decision or because of specific contextual factors, not feel particularly confident. In such cases, it appears more likely that a more analytically based, Type 2, approach will be adopted. Deeper understanding of this question and the information behaviour and need questions that flow from it would be particularly valuable.

Experienced decision makers, however, may change the course of a decision, depending on the demands of the situation. This may be possible for such decision makers as they use their own experience as a source of information (Choo, 2009) which might help them in deciding their next course of action. Thompson et al. (2004) also stated that decision making becomes quicker for experienced people. That said, these decision makers may not use the information in the same way as is implied in the theory that advocates analysing options before coming to a decision. An illustration is provided below for further understanding.

*I was able to recognise that one of the key processes that would follow would be a casualty bureau... and I quickly recognised that the area I worked was going to be a major ... So I made that executive decision to actually stand back*

In this excerpt, the respondent is able to relate the pattern to something that had happened before which helped him/her to decide on the next course of action. This finding is in line with Richter et al. (2009) who stated that when people have sufficient knowledge and experience, they are able to reject false information faster and more effectively.

It was also found that during emergency management, if a Silver commander is under time pressure, information seeking is limited. Decisions are made by recognizing a pattern. Richter et al. (2009) stated that knowledge (from experience) based validation of information is possible: '...even when the subject is put under load (such as time pressure)'.

It has been identified in the literature that in the absence of rules, and when the situation is complex, uncertain, dynamic and time constrained, Type 1 decision making is used by expert decision makers (Richter et al., 2009; Thompson et al., 2004). However, due to the criticality of the situation and the public high-risk, analytical decision making is recommended by researchers in emergency management (Crichton & Flin, 2002). Fitzgerald & Galloway (2001) supported this view stating that automatic decision making can lead to errors. Bennett (1999) in a similar way stated that experience might create obstacles in practice or may lead to acceptance of false information (Richter et al., 2009). In the excerpt below, the respondent suggests that commanders, although they may know all the options, may feel the need to explore further. This may be because there might be situations where information is available but may not be considered by decision makers, as in this example below where, although the person was deceased, it was not realised and people were not able to explore further options by considering this (in principle) available information.

*You are pretty much aware of your options although I have to say sometimes it is nicer to explore those options a bit further. You know you are aware of the situation..... the guy was actually dead on arrival at the hospital but nobody knew he was dead at the hospital. They had not followed that up. So we had this information out there that was available but wasn't being followed up*

However as Finkelstein et al. (2008) stated, even new information may not help decision makers as they decide unconsciously under time pressure. The findings of the present research, in a similar way, suggest that though decision makers may have different ways to get information, such as advisors, if they are experienced and familiar with similar situations, they may not seek further information or advice from others.

Thus, overall several views emerge from the findings and from the literature. There may always be an element of experience and pattern recognition when decisions are to be made by experts in complex, uncertain, dynamic and time constrained, environments, but there are many unanswered questions of detail about the interaction of expertise, information and decision making.

#### **4.3 Resolution of uncertainty**

The reported research indicates that information was not used solely to resolve uncertainty but was also to provide post-hoc justification. Interestingly Silver commanders explicitly indicated that information seeking occurred after the decision had been made:

*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.*

The use of post-hoc information seeking was linked to the difficulty found in articulating why they had made a decision and the need to justify the decision post hoc to others and to gain self-understanding after a process of analysis:

Silver commanders spoke of the post-hoc justification of decision making while being aware that it contravened preferred organisational procedures and policy. One respondent noted:

*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*

This approach resonates with Allen's (2011) finding that intuition can often lead decision making but is supported by deliberative information behaviour. In this case, however, the deliberative information behaviour seems to have been undertaken primarily to legitimize the prior decision rather than to resolve uncertainty.



This form of information seeking after decision making has not been explored in depth within IB research and suggests the need to extend Wilson's (1999) model of problem solving which assumes that the information seeking process stops after the decision is made and information is sought primarily to resolve uncertainty.

In his problem solving model (see Figure 1) Wilson (1999) stated that with each passing stage, 'the individual moves from uncertainty to increasing certainty'. Although the first and the second stage of the problem solving model may be seen in expert problem solving, the research findings suggest that in the third stage of *problem resolution*, irrespective of time pressure and complexity, experts may not consider how to find the answer to a problem but would act immediately. The problem is often resolved sub-consciously without the expert (Silver commander) being consciously aware of the process and therefore finding it difficult to articulate. Furthermore, Wilson's proposal that with each stage uncertainty is resolved may not always happen as suggested by this respondent:

*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*

In this statement, the respondent made a decision to ask his/her commanders to raid the hotel rooms which is a decision made (and falls under *solution statement* of Wilson's problem solving model), however, as s/he further added- "...I hope that was right - a right decision". This shows that even though a decision (*solution*) was made, the commander was still uncertain, so uncertainty had not been fully resolved. In such scenarios, Wilson (1999) added, '...if uncertainty fails to be resolved at any one stage, it may result in a feedback loop'. However, Silver commanders need to work under time pressure; in such scenarios, there might not be enough time for considering the implications of the feedback loop and trying to resolve the same problem again. Moreover, the findings suggest people may seek information even after the problem is solved and use the information after the decision has been made for post hoc justification and learning as indicated in the excerpt below

... absolutely yes, you will make an intuitive decision and then in retrospect you will justify that decision and funny enough I think the decision logs encourage that

Similar to this research finding, Chowdhury et al. (2011) stated that uncertainty does not decrease or cease by the end of the task as was stated by earlier researchers (Michael & Blake, 2007; Wilson, 1999). A need to modify the problem solving model for experts in time constrained environments in terms of information seeking is evident.

In Wilson's (1999) model, with the solution statement, the information seeking process stops. However, in this research, the findings indicate that even after the problem is resolved, information seeking takes place when justification needs to be provided. Thus, to accommodate information seeking after the problem is solved (decision made), Wilson's (1999) model as stated can be extended as shown in Figure 8.

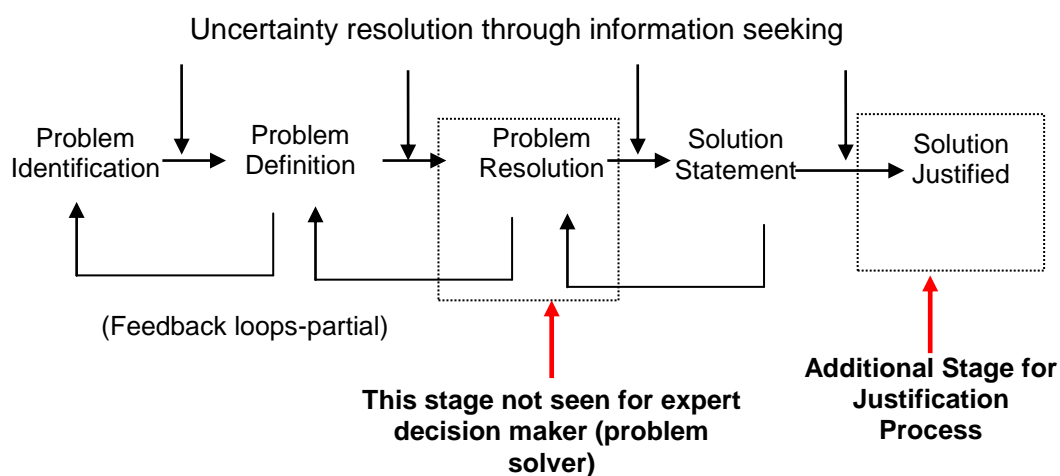


Figure 8. Expert problem solving model: an extension to Wilson's (1999) model

Literature on post decision making information seeking can be identified in decision making (Shani & Zeelenberg, 2007) and in marketing research (Perkins & Rao, 1990); however, it is underexplored in information science research. Choo (2008) merely stated that decision makers may choose a "justificationist" approach. Similarly, Ellis et al. (2002) touched on the

topic by stating that retrospective information search may take place. This concept of “post decision making information seeking” is an important phenomenon (Huber & Seiser, 2001; Jonas, Traut-Mattausch, Frey, & Greenberg, 2008; Shani & Zeelenberg, 2007) in information practices and merits further exploration.

While information seeking may occur post hoc to verify decisions, as suggested by Shani and Zeelenberg (2007) our reading of the results suggests that information seeking and use is motivated by a need to provide post hoc-justification either in addition to verification or instead of verification. It may also support learning. If undertaken for verification research indicates that information search for supporting decisions already made will be biased (Jonas et al., 2008). Respondents were acutely aware of this risk of bias:

*The reality is that, you would probably act, take the decision and then report your rationale. But of course you are recording your rationale to fit the choice that you took. You know, that's always the danger that you're just making fit. But that decision tends to come from the fact that you got to the point that decision has to be taken and there is no other way of taking information or some of the information that can make it better*

Other research in post-decision information seeking, reveals that people seek information to confirm decisions made (Frey, 1981; Jonas, Schulz-Hardt, Frey, & Thelen, 2001). As Jonas et al. (2008) highlighted ‘people show a preference for supporting rather than conflicting information’. This according to Frey (1981) is especially true when decision makers need to defend their decisions publicly rather than to themselves. To this Huber and Seiser (2001) added, justification pressure leads to information seeking in support of decisions made. In the case of Silver commanders, it needs to be available for the de-briefing after the incident. During the de-briefing process, the log book which they write to explain their actions and decision making processes is scrutinised. They might then have to defend their decisions in a public enquiry or court case. It was found that Silver commanders may make decisions

intuitively and then, for the ease of justification during the debriefing process, they might seek for information.

## **Conclusion**

In this paper we have explored information behaviour in a complex, uncertain, dynamic and time constrained environment. Three research questions were identified at the start of the paper: Are decision modes which don't conform to traditional IB approaches used? Does expertise moderate information seeking and decision making? Is information sought and used primarily to resolve uncertainty?

We indicate that both the context of the activity and individual differences influence choice of decision mode and associated information behaviour. The modes of thinking observed did not conform to the models used within IB research. We established that commanders engage in modes of decision making that incorporate Type one modes of thinking and that the time-sensitivity plays a key role in establishing which mode of decision making is used. Expertise was revealed as moderating the use of Type one modes of thinking, with expert decision makers being more likely to use Type one modes. We also established that in this context information is often not used to resolve uncertainty in decision making and indeed information is often sought and used after the decision is made to justify the decision. These findings provide further evidence on post-hoc information behaviour, but using empirical data from a naturalistic setting whereas research in this area has often been restricted to non-real time situations of laboratory experiments.

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