TJ4.3 Social and Behavioral Influences (SBI) on Decision-making by Emergency Managers

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1. INTRODUCTION

Previous research under the Weather for Emergency Management (WxEM) project focused on factors that impact the decision making of emergency managers during weather-driven events. That work documented the networks through which information flows among the various emergency support functions involved during severe weather (Losego et al., 2011; Montz et al., 2014). Specifically, the generation and utilization of information about hazards, their impacts, assessment of vulnerability and action consequences, and related decisions occur within the context of a complex, dynamic system of multi-disciplinary teams charged with the management of risk to property and lives. We found that there are many influences, including time pressure, within the system that cause significant feedbacks that interfere with knowledge transfer, resulting in lowered understanding and confidence. When decision makers have confidence in their understanding, they make a decision and move on to other required actions. When confidence is less than ideal due to lower states of competence (understanding), and comfort (trust), strong feedbacks force the system to gather more information, causing delays in actions or potentially wrong actions. Thus, It became clear that decisions are only partly about products and services; they are as much based on an EMs' mental model of a given situation as they are on products from the National Weather Service (NWS). And these mental models are, in turn, influenced by many factors, both tangible and more intangible,

The purpose of this research, then, is to understand better the role that confidence plays in EM decision-making beyond the information that is available to them. Other factors that influence confidence and thus decision-making, such as timing of information and messaging, are also identified and analyzed.

2. FACTORS INFLUENCING SITUATIONAL UNDERSTANDING

There has been some research on the systems that affect emergency management and the systems through which information flows and upon which decisions are based (Baumgart et al., 2008; Demuth et al., 2012). Baumgart et al. (2008) recognize three systems (environmental, information, and perceptual/cognitive) that interact in the emergency management framework. The number of emergency support functions comprising the EM community during a response magnifies the complexity of relationships illustrated in this framework. At the root of all these systems is situation awareness, which requires observing and understanding the elements of system as well as patterns among them, to decide on an appropriate action (Figure 1; Endsley, 1995).

The parameters in the gray box are generally well recognized within the emergency

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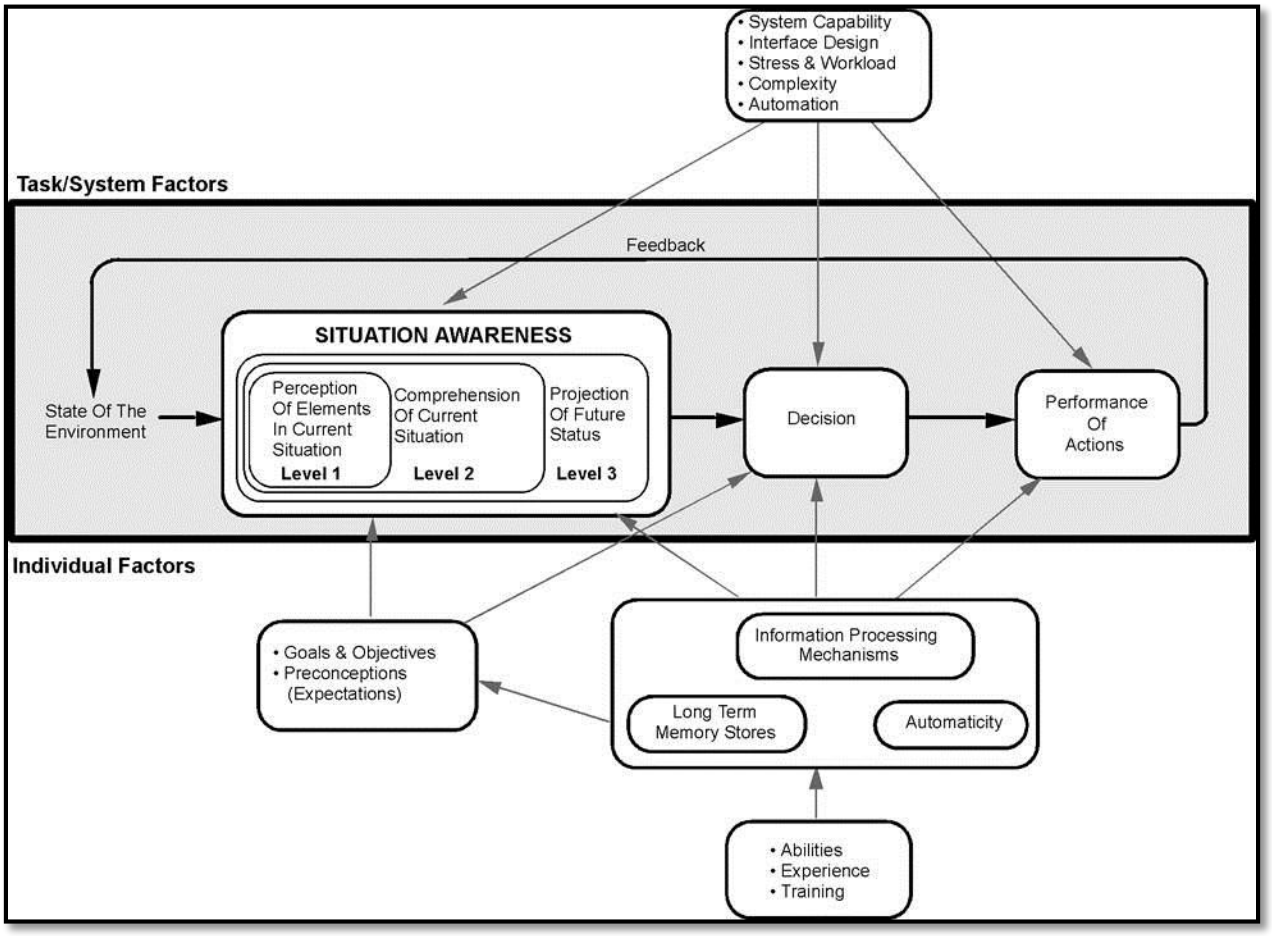

Figure 1: Situational Awareness in Decision-making

management community, as they relate to the tasks at hand and follow the well-known Simon (1955) model of decision making. Emergency managers are, in fact, very task oriented and are typically trained to follow a similar line of reasoning. However, to achieve confident "situational understanding," individual factors that are much less well understood, but go a long way in influencing an emergency manager's confidence, competence, and comfort must be addressed. There are factors that vary from event to event and, as shown in the diagram, are influenced by both system factors and individual factors, including training, experience and information processing. And, of course, they are influenced not only by the information that is provided to them but also by the delivery mode, the timing, and their sense of the forecaster's confidence.

To evaluate the influences of those factors, a number of surveys and interviews were undertaken, some as occasions arose, such as at state conferences of emergency managers or after an event through post-event phone interviews, and others through on-line surveys. The results reported here are those obtained from the on-line surveys. These were developed as a series of short surveys with the first collecting demographic and geographic data on respondents and subsequent surveys covering such topics as confidence, messaging, timing, training, and media. Each time a respondent takes a survey, it links to that respondent's original demographic survey, while maintaining anonymity.

3. **SURVEY RESULTS**

The results reported here center on the surveys associated with confidence, timing, and messaging, irrespective of EM demographics. These are preliminary results but they indicate trends that are important.

3.1 Confidence

The initial question in the confidence survey asked: When you think of confidence which of these comes to your mind first? The respondents were generally split between "forecaster's confidence" (37%) and "the confidence in the science" (40%). Clearly it makes a difference how the information is communicated by the forecaster. A follow up question asked respondents to rank the different ways a forecaster could convey their confidence. The results indicate that EMs want the forecaster to indicate the extent to which they are confident about the forecast using percentages, followed by words (Table 1). The forecaster's confidence is important to developing EM confidence.

Table 1: Forecaster Conveyance of Confidence

Conveying Confidence	**Percent**
Colors, green-yellow-red	7
Numbers, like DEFCON 1-5	13
Words, like high-medium-low	22
Probability with numbers (20%, 80%)	39
Probability with words (likely, probable)	19

Indeed, EMs rely on the NWS to a large extent when determining confidence in the science. When asked how they usually determine what the confidence in the science is, about 40% said they gather information from official NWS sources who they tell them their confidence, and another 15% do the same and then confirm with media or other sources. The other 45% reported that they look at multiple sources that tell them about confidence and then interpret that for themselves based on their experience and operational needs.

3.2 Timing

There is a strong relationship between confidence and time. EMs were asked how they perceive their understanding of the weather and their confidence as the event gets closer in time. The results are shown in Table 2. Not surprisingly, the largest percent (45%) said that understanding of the weather gets a lot better as the event gets closer in time, but fewer said confidence gets a lot better. More than 20% said that confidence stays about the same as the event gets closer.

Table 2: Impacts of Timing Frame

	Weather understanding	Confidence in decisions
Gets a lot better	45%	34%
Gets a little better	37%	37%
Stays about the same	10%	21%
Gets a little worse	0.5%	1%
Gets a lot worse	0.5%	0
No effect	6%	7%

There is no set lead time that EMs need. According to 72% of respondents, the amount of lead time needed is too dependent on the event type for them to specify a given amount. Specifically, when asked how they determine if they have adequate lead time, there is somewhat of a split on the factors that influence the amount of time they need (Table 3), though almost 40% indicated it depends of their understanding of the situation.

Table3: Determination of Adequate Lead-Time

Determining Factor	**Percent**
Based on potential consequences	23
Based on time needed to move resources	11
Based on time needed to pass information along to others	22
Based on SOPs or other action plans	5
Based on my general understanding of the situation	39

3.3 Messaging

The survey about messaging covered a range of topics from EMs' awareness of NWS products and services to their perceptions of the clarity, conciseness, and consistency of weather information. A lack of any of these requires EMs

to use valuable time to get the needed information. As a result, we asked what actions they first take to improve their understanding in situations where clarity, conciseness, and/or consistency are causing a problem (Table 4). As can be seen, more than half go to the NWS, either by phone or through NWS Chat for needed information, but in all cases, precious time is required.

Table 4: Actions to Clarify Understanding

Action Taken	**Percent**
Figure it out from information available	12
Watch TV to see what they are saying	15
Seek more information from sources other than TV	19
Call NWS or get on its chat session	52
Seek opinion from someone other than NWS	2

The final consideration in this phase of the research considers what EMs do with the information that they receive because of the implications it has for the format and the timing, among other factors, of NWS products and services. When asked what best describes how they use NWS products and services, almost 60% of EMs reported filtering them before passing them along to others (Table 5). Again, the process of filtering is time consuming and begs the question of how and why the information is filtered.

Table 5: Use of NWS Information

Use	**Percent**
I use products directly, for my operations only	10
I use many for my operations and forward to others after filtering to appropriate levels of need	59
I use many for my operations and forward to others without filtering	20
I do not use directly but pass along after filtering to appropriate levels of need	3
I do not use directly but pass along without filtering	2
I do not use NWS information directly but receive it from someone else after they have filtered it	3
I do not use NWS information directly but receive it from someone else unfiltered	3

3.4 Summary

Although preliminary, together these results illustrate the salience of factors that influence the decision-making of EMs in the face of impending severe weather. With the possible exception of the information in the messaging section, few of the influences relate to NWS (or other providers') products and services. Further, those that do relate to products and services are not necessarily easy fixes because, given the range of emergency support functions, one size does not fit all.

4. CONCLUSIONS

Reflecting on the gray box in Figure 1, levels 1, 2, and 3 that determine situational awareness are embedded in an individual's perceptions and understandings, which together define a mental model. Further, decisions are made based on one's mental model, as shown in the diagram. Thus, inadequate situational understanding or awareness can lead to a lowering of confidence in making decisions – which then requires a search for more information to confirm or modify one's understanding. At the same time, knowing the forecaster's confidence in the forecast (as opposed to just the probability of occurrence), is critical to developing the EMs' confidence. In turn, confidence is balanced with what is believed which comes from training and experiences, but also from what one is told from a trusted source.

Lead time continues to be a topic of much concern, and the results here suggest that, for an EM, lead time is relative. The necessary lead time varies with required tasks of the EM, with the potential impacts of the event and, most importantly, with the EM's understanding of a given situation. The greater each of these, the more lead time is needed. As a result, again, one size does not fit all. Different emergency support functions have different responsibilities that require different amounts of time. Even within an emergency support category, different events or different characteristics of the same type of event may require different lead times. Clearly, there is no easy answer to how much lead time is needed.

Messaging relates directly to both confidence and lead times. Where messages are not clear or are inconsistent, confidence is lowered and valuable time can be consumed seeking

additional information to build that confidence. The results here do not lead to specific conclusions or recommendations about how to best cast messages to be more directly applicable to EM needs, but rather suggest that additional research is required. Similarly, the fact that almost two-thirds of EMs filter the information received from the NWS before forwarding it to others requires additional research. There are numerous questions to be addressed around these topics.

As noted earlier, this is a preliminary report on the research that is currently underway. In addition to undertaking more in depth analyses of the surveys, the next steps include exploring the influences of comfort (trust) and competence (understanding) as they are affected positively and negatively by NWS and identifying leverage points where changes can lead to a more effective system.

5. **REFERENCES**

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