Investigating Incident Management Teams as Cognitive Systems of Systems via Network Analysis of Real Time Interactions

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Large scale disasters have highlighted the importance of avoiding coordination breakdowns, both within and between teams (DeChurch & Zaccaro, 2010). An incident management team (IMT) is staffed as an ad hoc multidisciplinary team of incident commanders with diverse backgrounds (e.g., law enforcement, firefighting, and emergency medicine) to manage information and make decisions with the delegated authority to act on behalf of the affected jurisdictions (Federal Emergency Management Agency, 2017). Since an IMT is comprised of five functionally different teams (i.e., Command, Plans, Operations, Logistics, and Finance/Admin), those component teams are in particular need to coordinate not only within but also between themselves.

Therefore, the current study aims to investigate an IMT's coordinating mechanisms to inform future policies and practices. Although team cognition has emerged as a coordinating mechanism at the team level in safety-critical domains (Fiore & Salas, 2004), little is known about an IMT's cognition as a coordinating mechanism. Despite attempts to apply team cognition to incident management (e.g., Jobidon et al., 2017; Majchrzak, Jarvenpaa, & Hollingshead, 2007; Mohammed, Hamilton, Tesler, Mancuso, & McNeese, 2015; Sætrevik & Eid, 2014), investigations of an IMT's cognition have largely focused on team performance and outcomes rather than coordinating mechanisms or processes (Fleştea, Fodor, Curşeu, & Miclea, 2017; Uitdewilligen & Waller, 2018).

This study focuses on coordinating mechanisms by viewing an IMT's cognition as interactions, inspired by interactive team cognition (ITC) theory (Cooke, Gorman, Myers, & Duran, 2013) and building on earlier works (Moon, Peres, Sasangohar, 2017; Moon, Sasangohar, Peres, Neville, & Son, 2018; Son et al., 2018).

Real time interaction data were collected at a simulated environment of a generic IMT facility; the Emergency Operations Training Center (EOTC); at Texas A&M University in College Station, TX. Interactions were observed and coded in real time in terms of initiator, receiver, technology (if any), frequency, and duration, using the Dynamic Event Logging and Time Analysis (DELTA) iPad-based tool for ease of coding with time-tracking.

Using the interactions observed and live-coded for three and a half days throughout four different scenarios, a directed and weighted network was created. To investigate component teams' contributing roles for the overall IMT's cognitive functioning, their centrality measures were examined. Centrality measures of a node show how central a node is in a network. The centrality measures were weighted separately by frequency and duration, as results and implications may differ by each weighting.

From the network of live-coded interactions, the centrality of nodes (representing the component teams) were calculated using the average frequency and duration as weights. The network was visualized in six different ways with node sizes adjusted to represent six different weighted centrality measures, i.e., frequency-weighted and duration-weighted degree, closeness, and betweenness. Results demonstrated that three component teams of interest contribute to an IMT's cognitive functioning in meaningfully different ways. Therefore, each component team deserves to be treated as a cognitive system, indicating the need to view an IMT as a cognitive system of system.

Our preliminary findings highlight potential benefits of adopting an interactionist approach, incorporating systems perspective, and employing network centrality measures, particularly for the purpose of characterizing how each component team contributes to an IMT's system-level cognitive functioning in different ways. A live-coding approach, however, did not allow us to investigate the contents of interactions.

As such, our forthcoming work will employ a retrospective coding approach, where the audio- and video-recorded interactions will be transcribed and coded in terms of their system-level cognitive goals. The resulting model of an IMT's cognitive processes is expected to become a base platform to discuss practical ways to better support scenario-based training practices and thereby lead to more rapid and better coordinated decision making to save lives and infrastructure.

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