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A MINDFULNESS BASED APPROACH TO EMERGENCY MANAGEMENT INFORMATION SYSTEMS (EMIS) UTILIZATION AND PERFORMANCE

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Research in Progress

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Abstract

The 13th of November terrorist attacks in Paris highlight a critical need within the emergency management (EM) domain to demonstrate the value of technological system capacities that support decision making. The world watched scores of police, paramedic, and fire teams communicating and coordinating together to save innocent civilian lives. Many researchers agree that systems should be designed informed by the "cognitive processes" used to respond to unanticipated emergencies. Mindfulness, within emergency management organizations (EMOs,) is created by the complex engagement of five organizational principles. They activate processes which produce capabilities uniquely supported by technology to anticipate and contain unexpected incidents for the EM domain. This paper explores organizational mindfulness (OM)) as a theoretical and methodological mechanism for design, assess and evaluation of emergency management information systems (EMIS). Mindfulness provides a basis for understanding both the EM domain and the organizational capabilities which allow for multiagency coordination. Design Science is proposed to conceptualize an IS artefact that refines our understanding of coordinated real- time decision making (CRDM). This research-in-progress paper adds to literature focused on system utilization and performance through the lens of the EM domain focusing on EMIS utilization to engage in CRDM within operational centres.

Keywords: Emergency management, organizational mindfulness, decision making, system utilization

1 Introduction

The recent terrorist attacks in Paris and Brussels highlight a critical need within the emergency management (EM) domain for capacities in situational awareness and threat analysis to support real time decision making before and during unexpected events. Beyond the economic and political ramifications are the social disruption caused by such attacks. These attacks not only saw unprecedented causalities with simultaneous incidents, but also the immediate militarization of two of the world's capitals in the initial response to the incident. Multifaceted, multi-layered threats like these underscore the challenge of major cities to adequately prepare and ramp up operations for perceived or suspected threats. Such incidents are a typology of the complex risk, threat, and hazard landscape affecting decision making within the EM domain. The reliance on technology to conduct surveillance and threat analysis among public sector emergency management organizations (EMOs), including civil defense agencies, often out of the public eye. While facets of technology integration in EM are pervasive and growing (Jefferson 2006), research approaches for assessing utilization and performance are lagging indicating a gap critical to understanding system effectiveness.

Crisis or Emergency Management Information Systems (EMIS) describe specialized systems used to support information and resource management, situational awareness, and maintenance of a common operational picture in EM operations (Belardo et al. 1984; Turoff et al. 2004; Iannella et al. 2007). They help EMOs operationalize dynamic processes using to enhance capabilities of emergency response teams to understand, formulate and rank problems and alternatives for EM information sharing and decision making (Belardo & Harrald 1992; Papamichail & French 2005; Fogli & Guida 2013). Arguably, EMIS represent a system of systems using modules of composite systems like group decision support systems (GDSS) to work together to support multiple operations. Their use to support operations is widely accepted, yet evaluation of their effectiveness to aid decision making is scarcely researched in EM (Curnin et al. 2015) and IS (Turroff et al, 2011) literature. This gap motivates the research to understand EMIS capabilities to support EMOs, prompting the question: *how can we determine that systems for EM decision making are appropriate, efficient and reliable for EMOs?*

Organizational mindfulness (OM) describes cognitive processes used in high reliability organizations (HROs), like EMOs, to adapt to unexpected events (Weick et al. 1999). Researchers like Guston & Sarewitz (2001) have called for real time technology assessment to support research and demonstrate a societal value of innovation. This call has been echoed by Van De Walle et al. (2009) to validate EMIS capabilities which is the motivation of this paper. The aim of this paper is to consider group and organizational cognition to guide evaluation of EMIS system design and inform our understanding of system-enabled coordinated real time decision making (CRDM). For the EM domain, OM provides an articulated theoretical framework to focus on reliability that emphases the role of technology in EM by characterizing interdependent and synergistic relationships between routine-based and mindfully-based performance (Weick et al. 1999). We consider the intervening role of utilization in the context of technology and group performance (Trice & Treacy 1988) along with the moderating affect of multiagency coordination in influencing both utilization and performance. We proceed in our investigation in a way that first considers the application domain, the characteristics and features of EMOs and EMIS which support CRDM. Section 3.0 then reviews OM within both the EM and IS domain to illustrate the role of capability in the assessment and evaluation of technology and organizational process. Section 4.0 presents a research model used to guide our analysis of EMIS utilization and performance based on OM. Section 5.0 describes the proposed methodology for research and next steps in our research in progress. We propose an approach to investigate a complex domain riddled with complex challenges and life safety priorities.

2 Contextualizing the Application Domain: EMIS in EMOs

To establish context and set the stage for our study, this section describes the domain environment including organizational actors and the system of interest. EMOs refer to entities with the primary (and often regulatory) responsibility for the coordination of jurisdictional response to an emergency, disaster, or crisis at municipality, provincial, state, national or international jurisdictional levels. Though situated within the public sector, an EMO responds to unexpected events using capabilities based on adaptable and flexible organizational structures, processes, resources and functions which support EM operations. These capabilities allow for competency of a core function of the EMO: multiagency coordination. Quarantelli (1978, pg. 18), described this as "tasks directed at relating organizations to one another effectively and relating capabilities of organizations to disaster demands." A focal point of multiagency coordination are the facilities and structures (both physical and organizational) which support EM operations. The facility of interest in our research is the operational centre, characterized by Perry (1995, pg.204) as "a function, a place and a structure." The operational centre serves as the physical location where strategic level decisions are made, often outside of the view of the public by diverse stakeholder groups representing public, private, and non-governmental organizations. The EMOs often serve as the custodian of these facilities with oversight of information systems deployed within the operational centres of many major cities, states, and countries.

EMIS are often built as systems of systems which may include, but are not limited to: knowledge management systems, group decision support systems, database management systems, resource management systems, learning management systems, and geographic information systems (Belardo et al. 1984; Van De Walle et al. 2009; Dorasamy et al. 2013). They are built to serve each phase of the EM lifecycle-preparedness, response, recovery, and mitigation-EMIS support a diverse set of functions from planning, training, decision making, resource management, situational awareness, document and financial management (Belardo et al. 1984; Iannella & Henricksen 2007). Table 1.0 illustrates the dimensions of EMIS designed for used by EMOs in decision making which have been the basis of current system development approaches. Derived from both KMS and DSS perspectives in IS literature, the following EMIS capabilities, and system components were captured using a concept centric matrix (Webster & Watson 2002)) to evaluate design dimensions in the application landscape. Research suggests that EMIS cater to a wide spectrum of organizations, jurisdictions, and settings both within operational centres and on-scene at incidents (Turoff et al. 2004). Decisions made within an operational centre are often made among an assigned group of individuals representing diverse levels of expertise or functional knowledge, who have a level of authority to commit resources and baseline understanding of the processes of their respective organizations (McLean, 2013).

Various models have been used and adapted to characterize EM decision making by super imposing theories to address the challenge of individual and group perception, judgement, consensus, and cooperation to make decisions to prevent or respond to crisis (c.f. Harnesk et al. 2009; Rodríguez et al. 2009; Turoff et al. 2004; Bharosa et al. 2010; Lee et al. 2012). These models have been limited by an inability to address the complexity of multiagency coordination which occurs within operational centres particularly. This is the research gap that is addressed in this paper. Kendra & Wachtendorf (2003, pg. 51) described decision making within the operational centre as an "artisanal craft" that "allow[s] for people to deploy rapidly adaptive strategies… the ability to become inspired by features in the surrounding environment, and to translate those inspirations into creative and innovative actions." Coordinated real time decision making (CRDM) is used here to describe a form of decision making unique to EMOs. We define it *as the engagement of groups of individuals in strategic level problem formulation and forecasting to develop alternatives and courses of actions to discover or manage unexpected incidents based on the capabilities available to the grou*p.

Table 2.0: Dimensions affecting the Design of EMIS								
Design Dimensions		**Researchers**						
		Van de Walle and Turoff, 2008	Jennex, 2007	Turoff et. al., 2004	Belardo & Pazer, 1995	Belardo & Hammond, 1992	Wallace et.al, 1985	Belardo, et.al. 1984
Type	KMS		X	X				
	DSS	X			X	X	X	X
System Capabilities	Communication Support		X	X				X
	Data Management (Input and storage)	X	X	X	X		X	
	Data Display (various elements in different formats)	X		X			X	X
	Data Analysis	X	X		X	X	X	
	Decision Making	X			X	X		
	Knowledge Mapping			X		X	X	
	Simulation Modelling			X	X			X
	Hindcasting Techniques	X				X		
	Reporting (ad hoc and routine)			X			X	
System Components	Database		X	X	X		X	X
	Normative & Prescriptive Models	X	X		X	X	X	
	User Interface for Display & Communication	X		X		X	X	X
	Easy to Use Language			X	X			
	Object Orientation Representation Tools	X		X	X	X		
	Sophisticated Graphics							X
	Educational Interventions			X		X	X	X
	Interactive use of data and models		X	X		X	X	X

Table 1.0 Dimensions Affecting the Design of EMIS (created by researcher)

We use CRDM to describe and account for the physical, functional and social dimensions of decision making within the operational centre. While much is known about the features and capabilities of EMIS, little is understood about how those system merge with organizational processes to enable real time decision making in EM (Iannella & Henricksen 2007) and reliable performance (Van de Walle & Turoff 2008). We posit that this consideration will help EM and IS researchers position design and organizational processes for more reliable performance and greater organizational interoperability.

3 Organizational Mindfulness in EM and IS

This section briefly discusses the roots of mindfulness for a baseline to orient our exploration of EMIS utilization. Mindfulness, which has its origins in the field of psychology (Langer, 1989), is seen as an approach to characterize present awareness and active engagement by individuals. The concept of individual mindfulness was extended by Weick et al (1999) to describe group and organizational attributes of collective and organization mindfulness (OM). This look at the collective capacity of awareness and activity occurring in adaptable, reliable organizations implied a perpetual state of being ready to respond to a situation. Once prompted by a trigger that is a deviation from routine processes, procedures or activities are detected, mechanisms which enable collective awareness, sensitivity and interpretation of such deviations are activated (Weick 1987; Weick et al. 1999). They define OM as *a*

capability for rich awareness of discriminatory details that facilitate the discovery and correction of potential accidents based on five processes described in Table 1.0.

Mindfulness Process	Organizational Cognitive Process
Preoccupation with failure	Increased attentiveness to all failures which offer opportunities to assess the health of the system, analyze near failures and focus on reliability of the system.
Reluctance to simplify interpretations	Use of methods to increase awareness of complexity from divergent perspectives preserved by system and process redundancies.
Sensitivity to Operations	Maintenance of situational awareness which provides an integrated picture of operations in the moment based on perception, synthesis, and projection.
Commitment to Resilience	Capacity to "bounce back" from unanticipated dangers after they occur and surprises in the moment through the use of informal networks and improvisation.
Under specification of structure	Migration of expertise through flexibility and organizational structure to link expertise with problems, solutions and decisions.

Table 2.0 Organizational Mindfulness Processes **(Weick et al. 1999)**

OM occurring within HROs, including EMOs, focus on collective cognitive processes providing a capability for awareness and activity. It describes a consistent mind-set prevalent in organizations that allows for a level of alertness that constantly evolves based on the information received or cues analysed in differentiating and interpreting them (Khan & Mirchandani 2008). Each OM principle contributes to a more holistic, and refined, understanding of distinctive attributes within the EM domain for the purpose of system design and operations. There has been a clear difference of opinion in IS on approaches to the concept and application of OM. Initial IS application focused on innovation, based on Weick and colleagues' work, identifying mindful and mindless decision making (Fiol and O'Conner, 2003) and innovation grounded in organizational capability (Swanson & Ramiller 2004). Butler & Gray (2006) proposed an alternate view of OM as a potential theoretical foundation to achieve reliable individual and organizational performance and interpret IS design, management, and operational use. This view characterized mindfulness as an openness to novelty, alertness to distinction, sensitivity to context, awareness of multiple perspectives and orientation in the present that occurs in individuals and collectively. This work described the adaptability of systems to respond to dynamic changes in environments to demonstrate reliable performance. Additionally, it alluded to the convergence of system function with organizational process in the area of business continuity. Further refinement by Van de Walle & Turoff (2008) argued for OM as an IS capability-based method of inquiry and interpretation enabling technological evolutions for DSS use in EM and information security.

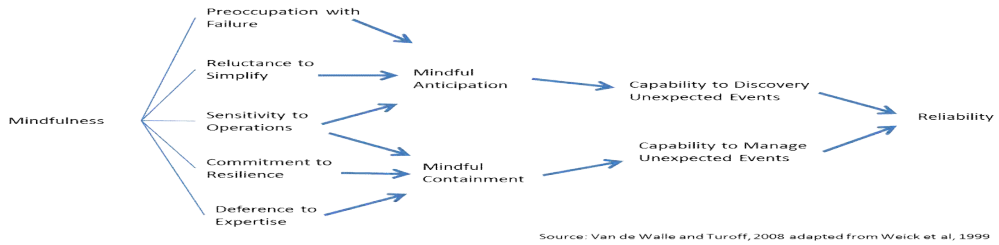

Figure 1.0 Mindful Infrastructure for high reliability (Van de Walle and Turoff, 2008 adapted from Weick)

This paper adopts the latter two perspectives for examining the ability of EMIS to support reliable performance based on mechanisms for system-enabled inquiry and interpretation capabilities (Butler and Grey, 2006). Figure 1 illustrates the capability-based approach proposed by Van De Walle in the design and operation of GDSS. System functions and features facilitate mindful anticipation or contain-

ment, leading to a capability for discovery and management of unexpisected events. The figure illustrates the base layer of our approach of building mindful infrastructure for reliable EMIS performance. Our perspective also considers the design of IS for high reliability environments which can operate within the context of OM processes to encourage specific capabilities. Considerable OM research emphasizes reliable performance as a consequence of activation of the principles and capabilities, yet a research approach that uses OM to guide our understanding of EMIS use and performance in the context of the EM domain remains elusive.

4 Theoretical Foundations and Research Model

This section applies OM and the Theory of Reasonable Action (TRA) as a lens to examine EMIS utilization in dynamic environments. It describes how system capabilities and organizational processes converge to support CRDM and lead to reliable team and system performance.

4.1 EMIS Utilization as an Intervening Variable

When considering the technological constructs which impacted performance, Trice and Treacy (1988) argued for the intervening role of IS utilization. They proposed an approach to IS utilization research based on the Theory of Reasonable Action where utilization was considered both as dependent and intervening variables in the assessment of IS performance. The focus of this analysis considers the characteristics of EMIS technology as a backward linking antecedent variable of utilization that is forwardly linked to performance through CRDM. Our interest is in system effectiveness for performance purposes, alternate to analysis of effectiveness based on task-technology fit posited by Desanctis et al. (1987). Other researchers have suggested the use of socio-technical theory (c.f. Harnesk et al, 2009) and technological acceptance (c.f. Stefi, 2015) which do not emphasize both utilization and team performance as key measures of organizational effectiveness.

OM processes contribute to building capabilities that we argue are an important part of the design and operations of EMIS intended for EMOs. We hope to highlight OM processes used to obtain and maintain a heightened awareness of operations that can inform design (Butler & Grey, 2006) and assess system features and components which emphasize a capability based focus. Figure 2 illustrates an adaptive conceptual model of utilization as we consider its intervening attributes in EMIS. The core of EMIS utilization is the capability for anticipation (discovery) and containment (management) of a validated or unexpected hazard, threat, or emergency (Van de Wall and Turroff, 2008). We argue that utilization based on mindfulness promotes CRDM through anticipation or containment activities. These activities take place in the EM lifecycle between the preparedness and response phases, also the place where technology and organizational processes work together to support decision making.

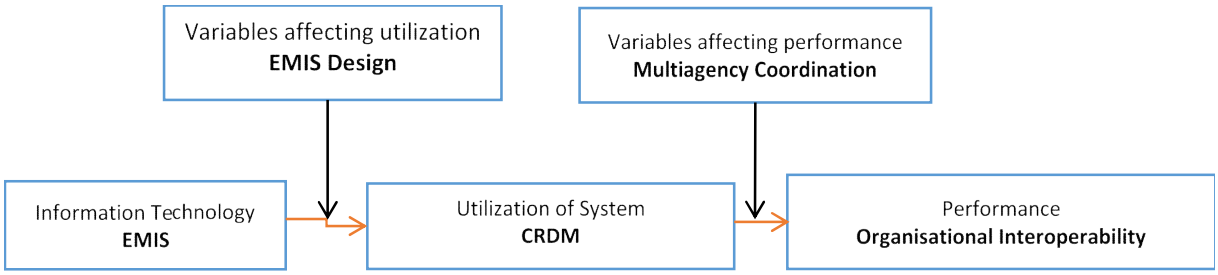

Figure 2.0 Utilization as an Intervening Variable (adapted from Trice and Treacy, 1988)

4.2 Mindfulness-Based Approach to EMIS Utilization Research Model

Mindfulness is applied here as a kernel reference theory to understand sense-making of organizational actions that specifically stimulate capabilities in response to stimuli that deviates from normalized operations. Extant IS and EM literature have used mindfulness as a reference theory, and we consider a view of OM that can link group cognitive processing to EMIS design and functionality. This paper argues that EMIS utilization occurs when CRDM is enabled by both EMIS technology and supportive OM processes to obtain and maintain a heightened awareness capability. Figure 4 illustrates the proposed research model to investigate this hypothesis. Following Trice and Tracy (1988), the forward and backward linkages of EMIS utilization affecting performance are visualized. While decision making is seen as a single component of performance in the interest of understanding EMIS utilization, significant research suggests that this is a core function of EMIS in these settings (Turoff, et al, 2004, Belardo et al, 1984, Curnin et al, 2015). EMIS are expected to provide information to support analysis and decision making in tandem with the organizational and structural processes used for incident management (Iannella et al. 2007). Consequently, they should be designed, implemented and operated in a manner which ensures that strategic level decision makers, who are end user groups, are equipped with the appropriate tools for CRDM.

Utilization research suggests consideration of other variables which may influence use and performance, and multiagency coordination is seen in that light. Multi-agency coordination has been described as a variable that affects both the use of technology (Lee et al. 2011) and the performance of organizations within the operational centre environment (Bharosa et al. 2010; Chen et al. 2008). Our research model illustrates CRDM that occurs as a result of EMIS technologies to help measure facets of utilization which demonstrate reliable performance as organizational interoperability through the following four propositions. **P1**: OM system capabilities which enable containment or anticipation of unexpected hazards or perceived threats support the activation of CRDM. **P2**: OM processes and organizational capabilities use EMIS to engage in CRDM to discover or manage incidents. **P3:** CRDM is an output of mindfulness based approach to functional, resources and process capabilities moderated by the tactical, technical and collaborative facets of multiagency coordination. **P4**: Reliable performance is a product of EMIS utilization that supports organizational interoperability through the demonstrable actions CRDM built on multi-agency coordination among strategic level decision makers.

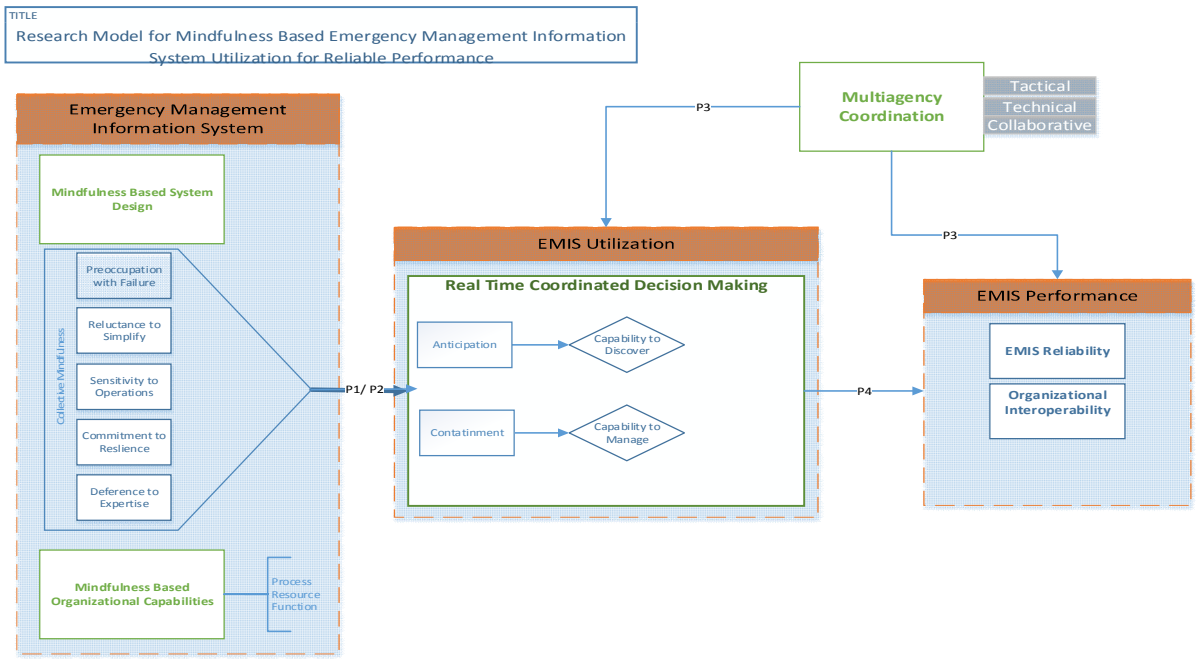

Figure 3.0 EMIS Utilization Research Model for Reliable Performance (created by researcher)

5 Proposed Methodology and Next Steps

This research proposes use of a design science research (DSR) methodology (Gregor & Jones 2007; Hevner 2007) to: (1) test the propositions of OM-based EMIS utilization and (2) build an IS artefact in the form of an adaptable model and assessment tool for EMIS design and evaluation. The concepts generated and defined would contribute to the theoretical and pragmatic needs for domain specific process-oriented design with intended use in mind to address the challenge of organizational interoperability within EM. We will draw heavily on a review of literature to qualitatively explore OM among EM practitioners and system developers to provide insight for the construction of generally applicable OM measures. We considered the DSR methodology appropriate to developing an artefact for evaluation of GDSS features in complex and dynamic environments. OM and TRA provide the theoretical lens to design GDSS intentionally, assess utilization, and examine performance in a methodically positioned manner to meet the needs of developers and practitioners simultaneously. By investigating the intervening role of utilization, we hope to deepen our understanding of systems enabled decision making. Mindfully designed tools would be organizationally oriented based on domain knowledge (Fogli & Guida 2013) and able to support coordinated real time decision making within the operational centre setting. An IS design theory (ISDT) approach specified by Gregor and Jones (2007) is proposed to develop meta-requirements to address the problem of evaluating the effectiveness of GDSS used by EMOs to support CRDM.

Our investigation focuses on CRDM among strategic level decision makers representing diverse organizations, each with their own respective structures, resources, and functional focuses. Fiol & O'Connor (2003) proposed a framework for mindfulness within organizations and observed the effect of expanded scanning on context-relevant interpretations in improving decision making. We propose the use of scenario-driven exercises to observe EM processes and activities and gather empirical data to guide the convergence of this integrative approach to IS and EM research. We applied aspects of this framework during a pilot workshop in November 2015 using an emergency scenario exercise and facilitated discussion to evaluate an approach that focused on anticipation and containment oriented decision making. The pilot provided validation of the simulation format which encouraged expanded scanning, context relevant interpretation and information analysis (Fiol and O'Conner, 2003) through a time-sensitive selection process. We hope to apply additional aspects of this framework on our analysis of EMIS utilization through activation of OM responses to discover or manage perceived threats through CRDM.

5.1 Next Steps

The severe social disruption caused by terrorist incidents and other crisis requires a deeper consideration for the ability of EMIS technologies relied upon to anticipate or contain unexpected events. This research aims to answer the call of (Butler and Grey, 2006) to explore OM in the design, implementation and operations of an applied IS. EM and business continuity represent areas of the IS domain where OM principles and processes are most exemplified. In our study we examine the application of OM to system design and organizational performance. For EMOs and other HROs, mindfulness provides a theoretical path to base our understanding of the relationship between EMIS design and capability with EMO process implementation. In agreement with Trice and Tracy (1988), EMIS utilization is viewed as having both backward links to technological and organizational variables, and simultaneous forward links which affect performance. The complexity of the EM domain and the dynamics of EMIS use require a re-evaluation of how DSS for groups are designed, used and studied in dynamic environments. While the concept of mindfulness is most prevalent in the area of IS innovation, we apply its principles and approaches to the design and utilization of systems in the natural environments from within which the principles are derived. By seeing EMOs as reliable organizations with flexible organizational processes that allow for adaptation and sensitivity to operations, systems that are de-

signed to operate to serve these organizations must and can have demonstrable value for multi-organizational end users.

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