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Evaluation of "Connectedness" in Multi-Organizational Decision Making: A Design Science Research Case

Alexis Amaye
University of College, Cork, alexis.amaye@gmail.com

Karen Neville
University College Cork, karen.neville@ucc.ie

Andrew Pope
University College Cork, apope@ucc.ie

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Completed Research Paper

Alexis Amaye
University College Cork
Alexis.amaye@gmail.com

Karen Neville
University College Cork
Karen.neville@ucc.ie

Andrew Pope
University College Cork
a.pope@ucc.ie

Abstract

Evaluation of the performance of systems is often done in isolation to evaluations of groups of people engaged decision making supported by systems, leaving much unknown about the effectiveness of information systems. The time has come for forward thinking on ways to better demonstrate the value of systems enabled with data analytic capabilities on and beyond organizational performance. This paper describes a longitudinal study to construct of an artefact designed to assist practitioners and system designers assess the reliability of system and team performance. Through observation of coordinated real-time decision making among emergency management (EM) practitioners, a broader understanding of system use in volatile and dynamic environments is gained. By extending organizational mindfulness and system utilization theories, the resulting artefact offers a novel approach to the evaluation of the people, processes, and emergency management information systems, which have significant impact on society. Building on a strong body of knowledge in this area, organizations are better able to transform their view of reliability and performance informed by context and not just system functionality.

Keywords

Information system evaluation, decision-making, design science research, emergency management, organizational mindfulness

Introduction

Data analytics in the emergency management (EM) domain brings together first responder public sector, non-governmental, hospital, and critical infrastructure organizations to prevent, response, recover, and mitigate crisis, emergencies, and disasters. Systems used in the domain are intended to support and enhancing complex and dynamic decision making through equally complex, multi-functional, composite platforms. There is a growing body of research showcasing the capacities and components of newer platforms enhanced with high levels of analytical capability to service EM organizations. While the research demonstrates the "suitability" of many applications, yet there are general gaps in understanding how the use of systems ultimately impact performance. Encouraged by the work of Butler and Grey (2006), organizational mindfulness and reliable performance was employed in this investigation to build an artifact to help to assess the connectivity of systems with the people and organizational processes using them. We frame the research through a capability-based view of performance in the design and operation of group decision support systems for EM. System functionality and features which facilitate anticipation or containment of threat are intended to lead to a capability to discover and manage unexpected events critical in the domain. Unfortunately, a major problem is the lack of clarity within the IS research community about the effectiveness of specialized systems used for decision making to ensure reliable, or repeatable, team performance within the domain (Hiltz et al.,2011). The environment in which these systems operate are described as requiring highly adaptable organizational structures and processes to respond to often volatile and dynamic events (Weick and Sutland, 2006). Consequently, there is general acceptance among researchers in the domain that for computer based systems and their design to be effective and adapted for decision support in this arena, there should be base understanding of the "cognitive process" involved in responding to unexpected events (Mendonca et al, 2001; Hiltz, 2011). While the emergence of technological capabilities such as data analytics are suggested to support cognitive processes, the extent at which they are effective in supporting group decision making indicative of this application domain are still not well understood.

There are just a few empirical works which look consider the organizational level implication of big data analytic innovations on reliable performance (i.e, Van de Walle and Turoff, 2008; Hiltz et al, 2011). Even fewer address gaps in understanding decision making enhanced or impacted by system and team interactions. The objective of this study was to develop an artefact for practitioners to use to evaluate the reliability of team and system performance using organizational mindfulness theory to address these gaps. This paper presents three elements of an eight-month longitudinal design science research (DSR) investigation which involved over 200 practitioners in Ireland. The first element describes the iterative design approach employed through simulation exercise in order to understand data sharing, interpretation, and analysis among representative groups of users. The second element presents a model which is abstracted during the design phase to visualize system utilization through dynamic decision making in order to construct the artefact. The third element presented in the paper is the artefact, the Organizational Mindfulness-based Information System (OMIS) Evaluation Framework, produced as an approach to understanding how data is analyzed in multi-organizational contexts. The results of the investigation provide an avenue for exploring performance evaluation in a way that supports the enhancement of competencies and capabilities of end users. The paper further contributes to the body of knowledge by calling for approaches to demonstrate the impact that enhanced systems have organizations thus providing evidence to support claims on the benefits of "connectednesss" resulting from system utilization.

Brief Overview to Frame Mindfulness and Utilization

This section provides an overview of the theoretical lens which informs the investigation in order to contextualize the application domain and forms of decision making indicative of the domain. Organizational mindfulness (OM) is described as a capability for rich awareness of discriminatory detail which facilitates the discovery and correction of potential accidents based on five processes observed in high reliability organizations (HRO) (Weick, Sutcliffe, & Obstfeld, 1999). It is viewed as a theory for understanding information processing and response as a cornerstone of EM decision making, and serves as the basis for artefact development. Emergency management organizations (EMO) embody the characteristics of HRO prime to adapt to change through the use of routine and mindful processes and approaches for the appropriate response to emergencies. The following table provides a description of the five processes which are attributed to the collective cognition observed within HROs that build a capability for awareness and activity which are used to describe cognitive-based interactions.

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.

Table 1 Organizational Mindfulness Processes (Weick et al, 1999)

IS and management researchers argue that each OM process contributes to the collective level of awareness that constantly evolves because of the information or cues which are continuously scrutinized or analyzed to interpret and respond accordingly within dynamic environments (Weick et al, 1999; Butler). A number of organizational science and management studies have investigated the distinctive attributes of OM within the EM domain highlighting its appropriateness as a kernel theory for the study. On both individual and organizational levels, mindfulness theory has been used to present ways for information processing and response in changing environments. This theoretical perspective has contributed greatly to our understanding cognitive-based processing which are engaged by individuals and groups to adapt to uncertainty (Amaye et al, 2016). From an OM context of cognitive processing, an understanding of how technology utilization is connected to performance.

When considering the technological constructs which impact performance, Trice and Treacy (1988) argued for the intervening role of IS utilization. They formulated 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. Our interest was 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 were found not to emphasize both utilization and team performance as key measures of organizational effectiveness. As a way of considering decision-making among EMO groups, utilization was seen as an intervening variable between the system and teams which perform together to anticipate or contain unexpected events which often have critical life safety implications. Coordinated real-time decision making (CRDM) was defined during the study to understand the integration of technology with organizational process among the various organizations present.

This section accounted for the attributes of mindfulness in the EM domain for the purpose of describing the research context and theoretical lens. The remaining sections present the methodological approach, analysis of observational data, and resulting artefact produced during the study to present our case to value higher units of analysis in IS research. A goal of this paper, in presenting the artefact, is to account for the construction of an artefact intended to evaluate mindful utilization of technology by teams. Using a fluid step-wise iterative design approach, construction was seen as occurring through building a knowledge base from literature associated with the application domain and engaging with EM practitioners in the application domain. The next section describes how the research study used scenario-based simulation exercises to inform the design, construction, and evaluation phases of the investigation.

Iterative Design Through Simulation Exercise

This section describes the design science research (DSR) approach employed in the artefact construction to depict the study environment for system evaluation that was inclusive of operational processes that help to illustrate system interaction for decision making purposes. The study used scenario-based simulation exercises commonly employed in EM as a form of capacity building in order to explore utilization and performance. Emergency exercises, according to David Alexander (2000, 2004, 2005, 2008) can be invaluable in building capacity and organizational resilience in disaster and emergency management. They are conscripted instantiations for performance improvement guided by an assessment of policies, procedures, and processes within an organization designed to ensure adaptability to unexpected change. Exercises are formulated simulations built around scenario narratives used to challenge the thinking and assumption-based decisions made by stakeholder groups. A significate amount of research in EM scholarship have used exercise simulations for technological system demonstration and testing purposes in operational research, but few evaluate system utilization directed towards performance. For the EMO, the exercise component of the preparedness cycle can be the most enjoyable organizational functional activity to build relationships and test operational processes. This is emphasized in a positively contextualized view of benefits for capacity building and resiliency as a consequence of regular engagement in exercise simulations (Dynes, 1976, Quarentilli, 1979, Perry, 1994, McEntire, 2005).

Iterative design took the form of observation of use of multiple systems in simulation exercises which were discussion- and operations- based, where the former consisted of facilitated table top simulation and the later consisted of the movement of organizational resources (i.e, equipment and teams). Organizational mindfulness has been used to express the collective intelligence of groups in informed decision making (Fogli and Guida, 2013). It was found to be spurred by connections among group members formed as a result of an awareness of expertise and trust in relationships. For a researcher lacking exposure and awareness of the features of these interactions in the application domain, it would be difficult to understand how decision making could be migratory and mutable at the same time. Domain awareness gathered through professional experience in both public and private sector EMOs afforded the researcher with a depth of contextual knowledge of decision making and process orientations associated with the domain. In order to distinguish activities and interactions observed, attention to system use, team interaction, and process implementation, a closed environment was considered most suitable. Fortunately, simulation exercises vary in complexity with environmental attributes and conditions that help to understand how information systems are combined to support EM decision making.

Specific attributes of simulation exercise were used to inform the respective DSR stages of design, build, and evaluation of the artefact. The following Table 2 provides a description of each of the simulation exercise types employed in the study. The scenario-based simulation provided a plausible, real-world environment considered highly reliable for data collection purposes. The table describes the narrative used during each exercise simulation to illustrate the variability in emergency types that an EMO responds. To scope the simulation in terms of study population, the table indicates the following numbers of: 1. Exercise participants directly and indirectly engaged in the scenario narrative as primary and support; 2. Response teams formed and observed during scenario narrative; 3. Observers on site during the exercise facilitation. The table also indicates the variable sources of data which informed the analysis of mindful utilization to construct the artefact. EMO subjects in the study employed an information management system (IMS) in the form of a white-board system to support information scanning, processing, and analysis.

Description of Simulation Exercise for DSR Investigation				
DSR Phase	**Simulation Exercise Type**	**Exercise Approach**	**Simulation Attributes**	**Simulation Scenario & Scope**
Design-1	Table Top Exercise	Discussion Based	Workshop based TTX using discussion and exercise props Journey mapping to guide exercise questioning	Terrorist threat with casualties 12 participants 2 facilitators 2 teams 1 observer
Design-2	Table Top Exercise (TTX)	Discussion based	Observation of TTX to practice notification and communication process. Co-located facility operator TTX. Simulated video and guided media team response Activation of IMS whiteboard	Chemical Fire with single casualty 19 primary 3 response teams 7 support 12 observers
Build-1	Simulation Exercise (SX)*	Activity Based	Observation of SX using facilitated discussion on operational processes Participants discussion through operational exercise activities Incorporation of real time information sources (maps, applications, and IMS whiteboard)	Explosion and Gas Migration with multiple injuries and single casualty 30 primary 5 response teams 12 support 4 observers
Build-2	Functional Exercise (FX)	Operations Based	Observation of FX using facilitated discussion and operational facility activation Participants notification and briefing exercise activities Incorporation of real time information sources (video, maps, applications, and IMS whiteboard)	Train Derailment with injuries and casualties 15 participants 4 response teams 3 support 1 participant/ observer
Evaluate	Full-Scale Exercise (FSE)	Operations Based	Observation of FSE involving multiple response teams Participants notification and briefing exercise activities	Helicopter Crash with multiple injuries and casualties +135 participants

			Scenario driven by real time information sources (radio, maps, applications, and IMS whiteboard)	11 response teams 35 support 3 observers

Table 2 Description of Simulation Exercise for Investigation

While many design processes in DSR come across as ephemeral and abstract, it's the focus on using *real systems* to solve *real problems* (Sun and Kantor, 2006) which oriented DSR as the appropriate approach to endeavor in this study through engagement activities used by the domain to enhance performance. A discussion on the iterations of design includes a discussion of instantiations where the artefact was able to change and mature as a result of interactions in these environments. A key feature of DSR is engagement with intended end user groups or stakeholder groups to inform the development of an artifact. An essential component of the design process of this study was an analysis of the engagement and relationship of social context on system utilization. The next section describes observations of group interaction focused on the discourse and cognition in the process of sense making, problem formulation, and solution identification. It presents a mental model as a conceptual processing technique to help visualize how mindfulness processes converge with utilization in the artefact design and construction.

Analysis through Observation of Dynamic Environments

There is a capacity among coordinated groups to make immediate decisions based on information that is dynamic (Perry, 2005; Alexander, 2008; Hiltz, 2011). In response to an uncertain event that is dynamic, EMO structures and processes adapt to rapid changes which occur in order to manage or contain a threat, whether natural or man-made. This section describes observations around a capacity of the groups to engage in these processes using systems and collective knowledge to perform (Butler and Gray, 2006). It presents conceptual processing and mental models encouraged in DSR literature (Veneable, 2012; Peffers et al, 2012) to support the various stages of the DSR methodology. DSR researchers can elect the use of a number of mental models to express knowledge generated about relational concepts. This includes concept centric mapping to illustrate both the complexity and the importance of the problem and the proposed solution.

The resulting analysis of the engagements observed served in the acquisition of an impression of team capability that informed both the function and the form of the artefact. The connectivity to practice and theory that was derived from this analysis situated group cognition between two interests of the observation-decision making activities and subsequent performance. In regarding the degrees of coordinated real time decision making occurring within the simulation, the observation of group cognition was demonstrated in processes used to scan and interpret new information that is gathered, assessed, and visually displayed using a white-board information management system (IMS). Performance as a consequence of these variables of organizational mindfulness and system utilization collide to attribute to decision outcomes that are grafted to operational objectives set by the decision makers themselves and then assessed based on feedback discussions following the exercise.

Artefact construction through data gathered in an observational study revealed that visual representations of sensory response to groups engaged in collective awareness for problem and solution formulation was a necessary component for operationalization. Dynamic group decision making is seen, heard, and sensed using scenario-based simulations of hazards and threats which are plausible and probable to generate the necessary response for observational purposes. Figure 1: Observational Analysis of the Second DSR Iteration is a visual analysis of the observational data obtained during a simulation exercise to illustrate its impact on the constructive process. It provides an illustration of the analytical processing of coding data gathered during the simulation exercise to derive meaning of coordinated real time decision making that is operationalized as a result of organizational mindfulness. Data collected through field notes are reconstructed and analyzed to provide an understanding of the value of the evaluative experience for the EM domain. The exercise setting provided the ideal environmental attributes to generalize theoretical knowledge of the phenomena, and these settings offer both slow and fast pace options. The discussion-based exercise used a scenario to generate conversational points to inform and train participants to both increase their understanding of the processes and build relational networks. The discussion based simulation exercise moved participants through a sequence of narrative prompts and subsequent activities demonstrating how a IMS was part and parcel of an organizational process to visualize OM.

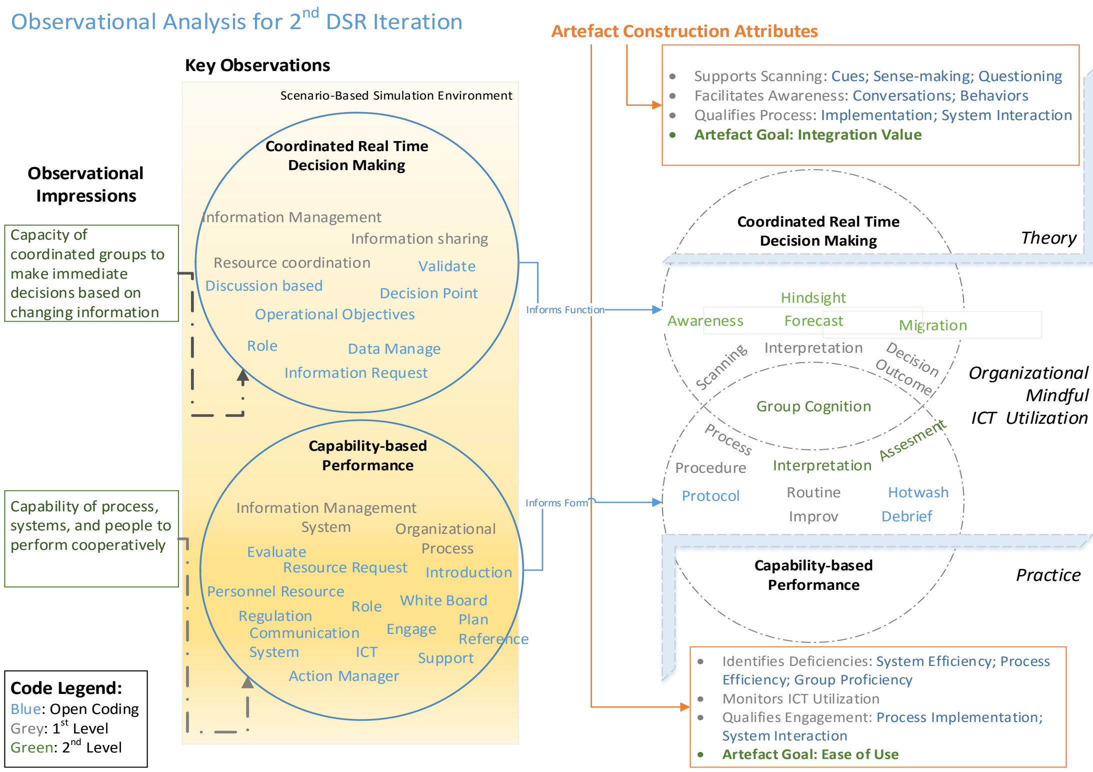


Figure 1 Observational Analysis for 2nd DSR Iteration

Artifact modification between the build and evaluate phases sought to support the value-laden focus of on the EM practitioner without posing as an imposition to the delicate balance of collaborative relationship building which occurs during an exercise simulation. This positioning of the artifact was validated through dialogue with subject matter experts during semi-structured interviews when asked about performance evaluation. The following section shows a high-level transformation of the artifact from the first version of a paper prototype (V2.0) during the second design cycle to the version of the paper prototype (V3.0) that was used to initiate the third design cycle which come as a consequence of engagement with stakeholders within the application domain.

The Artefact

This section describes the components of the artefact through two lens. The first as a design product which is informed by theory, indicating the variables derived from kernel theory and meta-requirements integrated in the artefact construction. The second is as a transformational journey informed by pragmatism and utility of the artefact design to serve its intended purpose.

OMIS Evaluation Framework: As a Design Product

During the initial iteration, a paper prototype and user criteria emerged while drifting between the problem and solution spaces in the observation of the first simulation exercise. Reflective conversation focused on observations and impressions of team interactions with systems produced the construction of the hand drawn artifact. This initiated the design and transformation of the artifact through subsequent design iterations of the project. The five organizational mindfulness capabilities, as variables in the artefact, were interpreted through the following identifiers: OM1-Attentiveness; OM2-Divergence: OM3-Awareness; OM4-Commtiment; and OM5-Migration. Utilization was viewed as an extension of the dynamic emergency response management information system (DERMIS) framework postulated by Turoff et. al. (2004), and were interpreted through the following identifiers: DR1-Metaphor; DR2-Role; DR3-Notice; DR4-Visual; and DR5-Exchange. The attributes of each variable resulted in the construction of 37 items within the three decision making dimensions of scanning, interpretation, and outcomes. These dimensions become the three categorical subscales used to measure system utilization and mindfulness in coordinated real time decision making. Within the artefact, these measurements are conceptualized based on the observation of participants in system supported or enabled problem formulation, forecasting, and management. The 37 variable measures used in the artefact describe an aspect of mindful utilization evaluated on a ordinal scale. The following graph provides each of the items measured within the artefact and its alignment with the kernel theory variables of organizational mindfulness and kernel methodology of DERMIS.

Instrument Measurement	OM1	OM2	OM3	OM4	OM5	DR1	DR2	DR3	DR4	DR5
Information Support										
System clearly presents information for threat/hazard monitoring and assessment		X				X				
System supports processes to exchange and transmit threat/hazard information to users	X						X			
System allows users to translate monitored data to task response	X					X				
System allows users to receive data appropriate to their role				X			X			
System users engage in processes to sense or gather dat for a broad understanding of threat/hazard			X							X
Decision makers receive notification of available and most current data to maintain environmental awareness			X		X			X		
Decision makers have continual access and use of most current data				X	X				X	
System clearly presents information for processing threat/hazard		X							X	
Time to notify and activate response personal on-scene					X			X		
Organizational Process										
System support decision making processes for problem formulation and alternatives		X								
System supports processes to continually assess resource				X					X	
System support decision maker(s) with data to perform analysis			X					X		
Decision makers obtain information to advice external stakeholders					X					X

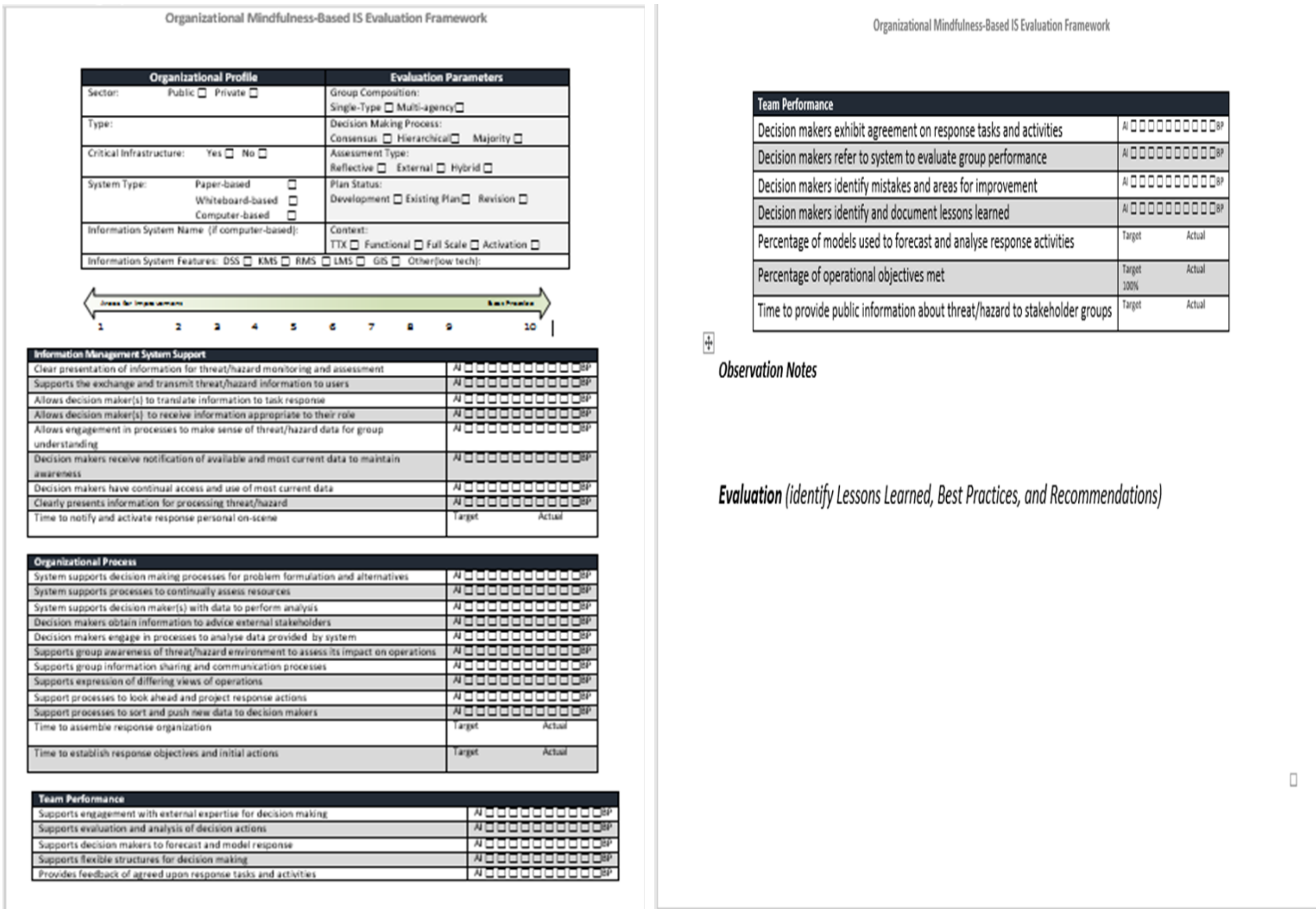
Instrument Measurement	OM1	OM2	OM3	OM4	OM5	DR1	DR2	DR3	DR4	DR5
Information Support										
Decision makers engage in processes to analyze data provided by system	X					X				X
System provides group awareness of threat/hazard environment to assess its impact on operations			X					X		
System supports group information sharing and communication processes	X					X	X			
System supports expression of differing views of operations					X				X	
System support processes to look ahead and project response actions		X								
System support processes to sort and push new data to decision makers				X		X				
Time to assemble response organization								X		
Time to establish response objectives and initial actions	X							X		
Performance										
System supports engagement with external expertise for decision making					X		X			
System support evaluation and analysis of decision actions				X					X	
System supports decision makers to forecast and model response solutions		X				X				
System support flexible structures for decision making					X	X				
System provides feedback of agreed upon response tasks and activities			X					X		
System users engage in processes to exchange data using voice, video, and/or text	X									X
Systems demonstrates a capacity to support organizational processes and structures to achieve tasks and actions		X				X				
Decision makers exhibit ability to improvise tasks to react to changes				X						

Instrument Measurement	OM1	OM2	OM3	OM4	OM5	DR1	DR2	DR3	DR4	DR5
Information Support										
Decision makers obtain external expertise to make decisions			X		X					
Decision makers exhibit agreement on response tasks and activities				X			X			
Decision makers refer to system to evaluate group performance	X								X	
Decision makers identify mistakes and areas for improvement	X			X						
Decision makers identify and document lessons learned	X			X						
Percentage of analytical models used		X							X	
Percentage of operational objectives met			X			X				
Time to provide public information about threat/hazard to stakeholder groups					X			X		

Table 3 Instrument for CRDM Framework

Design the OMIS Evaluation Framework initially sought to address the problem of a need for better assessment of the effectiveness of systems to support decision-making. Its transformation into a performance evaluation data collection tool enabled focus on specific items and measurements to support the observation of mindful utilization. The final iteration of the artefact separated the 37 measures into three areas: Information Support, Organization Process, and Performance. As a result of the iterative design cycles, the scale was designed to provide both descriptive and prescriptive insights to express the complexity of people-process-system interaction for the purpose of performance evaluation. Below is Figure 2: OMIS Evaluation Framework which shows the integration of the above described measurement instrument within the artefact. The artefact contains four input segments: organizational profile, simulation evaluation parameters, OMIS measures, and notation area for observational and evaluation content.

The framework layout in the image has been compressed to allow for the display of the primary sections on the first page. The second page is designed to allow for notation of observations and visual points which aide in identification of lessons learned and best practices. The italicized prompts are provided to prompt the end user, or EM practitioner using the artefact, to consider indicators that help is crystalline impressions which were valuable to process, system, and operational improvement. The orientation of the second page is present above in portrait, but the paper prototype is in landscape orientation to allow for space to record notes, draw diagrams, and provide qualitative data. The next section describes the journey of the artefact as a design process informed by engagement with practitioners in simulation exercise environments, and its impact on the design product.



Organizational Mindfulness-Based IS Evaluation Framework

Organizational Profile	Evaluation Parameters
Sector: Public ☐ Private ☐	Group Composition: Single-Type ☐ Multi-agency☐
Type:	Decision Making Process: Consensus ☐ Hierarchical☐ Majority ☐
Critical Infrastructure: Yes ☐ No ☐	Assessment Type: Reflective ☐ External ☐ Hybrid ☐
System Type: Paper-based ☐ Whiteboard-based ☐ Computer-based ☐	Plan Status: Development ☐ Existing Plan☐ Revision ☐
Information System Name (if computer-based):	Context: TTX ☐ Functional ☐ Full Scale ☐ Activation ☐
Information System Features: DSS ☐ KMS ☐ RMS ☐ LMS ☐ GIS ☐ Other(low tech):	

1 2 3 4 5 6 7 8 9 10

Information Management System Support	
Clear presentation of information for threat/hazard monitoring and assessment	AI ☐☐☐☐☐☐☐☐☐☐ BP
Supports the exchange and transmit threat/hazard information to users	AI ☐☐☐☐☐☐☐☐☐☐ BP
Allows decision maker(s) to translate information to task response	AI ☐☐☐☐☐☐☐☐☐☐ BP
Allows decision maker(s) to receive information appropriate to their role	AI ☐☐☐☐☐☐☐☐☐☐ BP
Allows engagement in processes to make sense of threat/hazard data for group understanding	AI ☐☐☐☐☐☐☐☐☐☐ BP
Decision makers receive notification of available and most current data to maintain awareness	AI ☐☐☐☐☐☐☐☐☐☐ BP
Decision makers have continual access and use of most current data	AI ☐☐☐☐☐☐☐☐☐☐ BP
Clearly presents information for processing threat/hazard	AI ☐☐☐☐☐☐☐☐☐☐ BP
Time to notify and activate response personal on-scene	Target Actual

Organizational Process	
System supports decision making processes for problem formulation and alternatives	AI ☐☐☐☐☐☐☐☐☐☐ BP
System supports processes to continually assess resources	AI ☐☐☐☐☐☐☐☐☐☐ BP
System supports decision maker(s) with data to perform analysis	AI ☐☐☐☐☐☐☐☐☐☐ BP
Decision makers obtain information to advice external stakeholders	AI ☐☐☐☐☐☐☐☐☐☐ BP
Decision makers engage in processes to analyse data provided by system	AI ☐☐☐☐☐☐☐☐☐☐ BP
Supports group awareness of threat/hazard environment to assess its impact on operations	AI ☐☐☐☐☐☐☐☐☐☐ BP
Supports group information sharing and communication processes	AI ☐☐☐☐☐☐☐☐☐☐ BP
Supports expression of differing views of operations	AI ☐☐☐☐☐☐☐☐☐☐ BP
Support processes to look ahead and project response actions	AI ☐☐☐☐☐☐☐☐☐☐ BP
Support processes to sort and push new data to decision makers	AI ☐☐☐☐☐☐☐☐☐☐ BP
Time to assemble response organization	Target Actual
Time to establish response objectives and initial actions	Target Actual

Team Performance	
Supports engagement with external expertise for decision making	AI ☐☐☐☐☐☐☐☐☐☐ BP
Supports evaluation and analysis of decision actions	AI ☐☐☐☐☐☐☐☐☐☐ BP
Supports decision makers to forecast and model response	AI ☐☐☐☐☐☐☐☐☐☐ BP
Supports flexible structures for decision making	AI ☐☐☐☐☐☐☐☐☐☐ BP
Provides feedback of agreed upon response tasks and activities	AI ☐☐☐☐☐☐☐☐☐☐ BP

Organizational Mindfulness-Based IS Evaluation Framework

Team Performance	
Decision makers exhibit agreement on response tasks and activities	AI ☐☐☐☐☐☐☐☐☐☐ BP
Decision makers refer to system to evaluate group performance	AI ☐☐☐☐☐☐☐☐☐☐ BP
Decision makers identify mistakes and areas for improvement	AI ☐☐☐☐☐☐☐☐☐☐ BP
Decision makers identify and document lessons learned	AI ☐☐☐☐☐☐☐☐☐☐ BP
Percentage of models used to forecast and analyse response activities	Target Actual
Percentage of operational objectives met	Target 100% Actual
Time to provide public information about threat/hazard to stakeholder groups	Target Actual

Observation Notes

Evaluation *(identify Lessons Learned, Best Practices, and Recommendations)*

Figure 2: OMIS Evaluation Framework, v4.0

OMIS Evaluation Framework: As a Journey

DSR is often criticized as a highly subjective and even "mystical (Cross, 1999)" process where the researcher relies on his or her own perception-based assumptions of a problem to propose a solution oriented in solving that described problem. The data obtained from the combination of ethnographic and qualitative analysis was compared across the design cycle iterations to demonstrate the maturation of the artefact as a result of engagement with practitioners who formed the body of study participants. The table illustrates the journey of the artefact from a sketch conceptualization from the designer's mind into a paper based prototype that is transformed across multiple iterations through engagement in the complexity of real-world simulation environments that are resistant to traditional experimental control. What is not depicted in visual representations are the challenges and difficulties associated with the study using a DSR design, or the obstacles arising from using the methodology in artefact development. However, the table does illustrate the transformations of the artefact informed by insights obtained from observation of simulation environments.

The investigation demonstrated that only through engagement in the application domain that OM process which inform design are able to become objective tools for abduction of inferences to better represent the compositions of the problem for the purpose of solution formulation. The strategy proposed in this study demonstrated the artefact construction process as more than an abductive representation of the solution orientation. It further supports that investigated human and computer interaction should focus on obtaining research findings from the application domain through interactive engagement with users in the domain. This was based on formative evaluation through observation to formulate and implement the prescribed artefact.

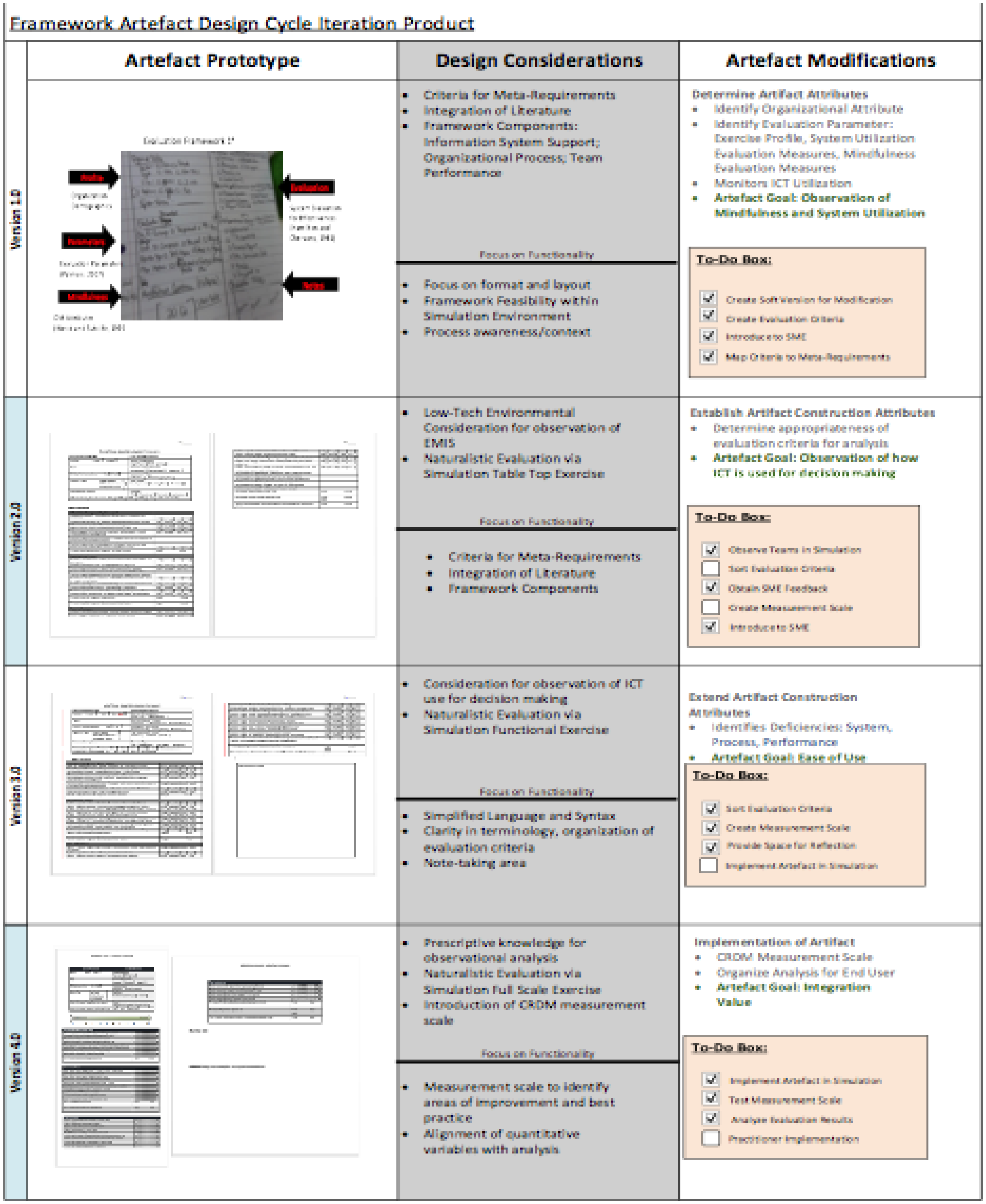


Figure 3: Framework Artefact Design Product

Validation of the prescriptive artefact through engagement with practitioners recommended in DSR guidance ensured that the process for artefact design adhered to and generated insight on the team performance. The criteria for evaluation was based on an analysis of the impact of organizational mindfulness on system utilization and team performance to measure organizational effectiveness from the perspective of the needs of practitioners in the application domain. The way in which the design process met this use criteria was determined through implementation in the simulation environment and by SME consultation who provided feedback on the artefact. An enhanced understanding of mindful utilization was obtained, and a better understanding of the paths in which data is analyzed and integrated in decision making was clarified. Effectiveness for the end user EM practitioner was closely associated with both OM processes and team reliability, and not system functionality. By evaluating systems use intended for the EM domain, this study produced an artefact to assess mindful utilization for practitioners in a space where volatility and dynamic uncertainty are mainstays.

Conclusion

This paper presented the findings obtained during a longitudinal DSR study which resulted in the development of an IS artefact called the OMIS Evaluation Framework. Construction in the study was derived from obtaining necessary, and highly contextualized, data to develop empirical abstractions for theorization of the phenomena of interest: mindful utilization in dynamic environments. As a study in the "landscape of experimental method (Collins et al, 2004)," the paper presented the use of conventional observational and non-conventional DSR and simulation approaches in naturalistic experimental environments for artefact design. It called for attention on addressing gaps in understanding organizational and multi-organizational information system use to contribute to the community's view of the effectiveness of newly developed technologies. Flexibility, or the adaptability of organizations to respond to new and changing requirements, is found to have a positive impact on both the organization and management. The paper extended this perspective with a focus on an application domain that demonstrated high levels of agility in order to engage in decision making tasks where life safety were the organizational focus. This paper argued that mindful utilization of information systems contributed to a fluidity in organizational decision making which supported and enhanced performance. Unfortunately, a tendency to focus on ICT and not the enabling processes and structures which are engaged in its use have limited our understanding of effectiveness and reliability.

For a developer who is not oriented or remotely acquainted with the EM as an application domain, it would be difficult to derive the elements and variables which would be most relevant to an objective oriented solution. Often times developers are called into an EMO to help design and build a system without the a priori knowledge of the domain which ultimately influences and impacts the use of information systems. This case is representative of a unique application domain where group cognition affects technology utilization in concrete ways with impactful outcomes on the ability of organizations to protect the communities at times of crisis, emergency, and disaster. Organizational mindfulness was selected as a kernel theory to constrain design drift and focus reflective conversation in order to frame the problem and solution space in a step-wise fashion. The research sought to communicate an approach to navigate through the ebbs of abstraction and flows of ideation for the sake of creation, progress, and understanding. To that end, the research illustrated that, bound to DSR as a method, are opportunities to reveal a process for reasoning that can be expressed, and should be expressed in IS research. Another attribute which is revealed in this case study focused on the EM application domain, which can be seen as a limitation to generalizability, is in the area of access for the purpose of design. The environment of many HROs are highly secure, many are identified as critical infrastructure like nuclear facilities or fire stations, so the ability to access the level of decision makers who are engaged in coordinated real time decision making is a privilege.

The artefact was evaluated based on the learnings gathered from real world exposure to environments and stakeholders of the application domain. The solution manifests in the observations of how the ICT is used by people to engage in organizational processes specific of the domain. A number of limitations were recognized in terms of applying new knowledge about mindful utilization outside of dynamic environments such as HROs. The following research findings were produced during the study:

CRDM as an observable phenomena of mindful ICT utilization: ICT utilization was contextualized as an intervening variable between organizational process and system design, and postulated as coordinated real time decision making (CRDM). The key finding was that the impact that organizational mindfulness has on CRDM is an observable phenomenon within emergency management organizations having a significant impact on operations research. As a new variable in which to view system use for the EM domain, an operational definition was developed in order to anchor the investigation on the core activity of interest, articulated in literature and recognized in the body of knowledge as a cornerstone of the domain. Reliable performance of, as a result of CRDM, was regarded as being system and team consequence of mindful utilization, the connection between the people, process, and system.

Application domain as source of artefact inspiration, validation, and adoption. The investigation was framed around the application environment to establish a parameter in which the design process could be undertaken and employed in the development of the framework artefact. Such approaches to the application domain serve to enrich the DSR process and product.

CRDM being best understood through team observation. System utilization within the multi-organizational context in EM is best understood as an intervening variable between organizational process and reliable performance. The investigation identified a number of gaps in the body of knowledge through an integrative literature review of EM and IS literature focused on decision making and system use. The investigation results addressed gaps associated with demonstrating the effectiveness of system to support organizational processes implemented by strategic level teams. This was done through direct, indirect, and participatory observation of teams engaged in CRDM.

Multi-Agency Coordination as the intervening variable between mindful process and utilization. The investigation revealed that the strength of the relationships between organizational representative had a direct impact on the demonstration of CRDM.

The biggest avenue for future research would be in the advancement of the paper-based artefact to a digitized format for broader deployment within other HRO and non-HRO settings. This investigation adds to our understanding of reliable system and team performance, and future research undertaking further field investigations would allow researchers to assess and understand organizational agility and performance as outcomes of flexibility.

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