

Towards an Information Architecture Oriented Framework for Emergency Response System

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ABSTRACT

Emergency, situations characterized as high consequence, low probability, and short decision time, create a unique decision-making environment that must be conscientiously supported. Historically, one of the techniques business has used to improve complex processes is a maturity model. Organizations should create the capabilities to react to information sharing needs in advance, not react an ad hoc manner to the information crisis. Based on the IT-Capability Maturity Framework (IT-CMF), we detailed some aspects of this model from an information architectural perspective to examine a country wide emergency service. Although information system and information technology (ISIT) have been emphasized in emergency management system, architectural aspects- a structure emphasized semantic description however have been of limited considerations.

We propose a framework to analyzing architectural aspects for information sharing that can help improve emergency response system. The framework is discussed and exemplified with a case study. We conclude that the proposed framework provides a deeper understanding of information in use from technical and managerial aspects during emergency response. Guideline for further improvement will be the focus in our future work.

Keywords

Emergency response, Maturity Model, Information Architecture, Information Sharing

INTRODUCTION

Continuously investment on technology and rising costs for emergency service put pressure on the public service system (Wiederhold, 1992). Not only IT supports, sophisticate information management along cross-organizational service provides huge potential for improvements on efficiency and effectiveness. In the respond to an emergency, a system made up of various actors and resources. Such a system of actors and resources can be regarded as complex socio-technical system (Gnter Ropohl and Gunter, 1999). All the actors directly or indirectly involved in delivering the care to the patients/casualties in cross-disciplinary services are assisted and provided with resources, such as information. One approach to the field of quality management is maturity assessment, assessing “the state of being complete, perfect, or ready” (Paulk, 1993). The current state of emergency service is that all the involved organizations try to improve the performance quality within individual level. While all parties are interested in advancing efficiency and effectiveness of the overall performance, each party seeks to ensure own quality and may also have different perception of how to best develop the emergency service. In order to advance the emergency service, which is to produce high quality and efficient services for saving lives in a timely manner, information sharing and collaboration is key determinant. Studies have highlighted on ITIS investment and management. However, information itself is not that difficult—left undisturbed, just sits in silicon storage or on a piece of paper. The challenges lie with the people and processes using or seeking that information (Brandeau et al., 2005, Plsek and Wilson, 2001). Therefore, in order to improve information sharing, focus on managing information from both technical and behavioral perspectives under such socio-technical system is required. In order to address this, we propose an information architecture (IA)-oriented framework: architecture is used when the relationships among the components are complex, and historically, one of the techniques have been used to improve complex process is a maturity model. Based on IT-Capability Maturity Framework (IT-CMF), this paper presents an approach to assess the maturity of the IA, which forms the foundation for capability to efficiently engage in key components of managing information sharing. Therefore, IA would provide comprehensive analysis on critical information – thus examines if information is provided a timely manner to save lives, limit damage and accelerate recovery.

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From various maturity models, we chose IT-CMF due to its overarching character and its focus on capabilities (Curley, 2004). It interfaces with other prominent frameworks that provide a reference model in form of maturity levels and assessment techniques. Furthermore, it assists organizations in improving IT management and organization performance. The IT-CMF addresses Enterprise Architecture Management (EAM), one of the structured 32 critical processes. Within this process the value of IA is emphasized (www.ivi.ie). In this sense, EA is a pre-cursor for the design and enforcement of the co-ordination between disparate organizations.

METHODOLOGY

This study combines literature review and case study research in order to develop the information architecture (IA)-oriented CMF. Design science will be adopted for the proposed framework evaluation.

Literature is used as primarily in this paper. Literature provides an excellent range of comparison groups that otherwise might be unattained (including information architecture, crisis management, emergency service and response system, data communications, and inter-organizational information systems). These data could be collected, analyzed, and incorporate with the interview or observational data. Case study is based on an emergency response unit in Ireland, including previous analysis results, in person interviews and field visits. Questions asked probed difficulties faced by the handling team, what support tools were made available, the effectiveness of these tools, and the supporting architecture for emergency service. According to design science (Hevner et al., 2004), the artefact presented in the paper is a Method artefact of the IA maturity framework. Evaluation of relevance to “determine the effectiveness in contributing to solve the addressed problem”, and future work within a focus group interview will be a preferable evaluation instrument.

RELATED WORK

Information sharing, and in particular, real-time information provides for better and efficient response to emergencies, and helps to save time and lives. In this paper, we consider information sharing with mature architecture support should improve the emergency response coordination.

Information Architecture (IA)

Architecture is used to organize information about a topic in order to manage it in a structured way. IA is used whenever a high-level overview of interrelated information components wanted to be defined, and when the relationships among them are complex and difficult to understand (Wurman, 1990). It is noted that no single term universally describes an encompassing framework for managing information as a resource (James et al., 1989). In this context, IA combines the background theory, design principles, and diagrams representing the meaning of gaining insight from information (Evernden and Evernden, 2003).

From related research review (James et al., 1989, Everden, 2003, Rosenfeld and Morville, 1998) we can conclude that data structure aspect has been emphasized, but the behavior perspective how information is used/interacted among all the actors is lacking. Architecture exists because of its practical usage of the information. In our work we describe IA is objects, which are representing/defining the structure of a information, structure includes technical aspects as defining and standardizing the information elements, the interfaces and relationships between the various information elements, and behavioral aspects that the relationship of how the information is managed for exchange and share processes among multiple parties.

Maturity Models

Maturity models related to information management have been proposed (Becker et al. 2009), for instance the frequently referred Capability Maturity Model (CMM) (Paulk, 1993). These models are in essence process improvement initiatives and are a means of assessing the maturity of an organization’s ability to perform a specific process. Although prominent maturity models describe in detail assessment approaches they are often limited in providing guidelines on how to improve maturity levels. The IT-CMF maturity model not only provides reference models, but also methods and activities to improve the current situation. CMF model presents the understandings that maturity models contain two aspects, one capturing the assessment of the current status and another one guiding organizations towards higher maturity levels (Van De Ven and Poole, 1995).

As such, in considering of inter-organizational service and objective of IA improvement, we select the IT-CMF in our research. Maturity models have been proposed for information management and collaboration. According to Doug Laney (2002), enterprises, emergency response chain is seen as enterprise for this research, must adopt

a method for gauging their “information maturity”. In sense, we propose an information and architecture focused maturity framework to analyze information sharing for a specific setting of emergency response system.

IA-ORIENTED FRAMEWORK FOR EMERGENCY RESPONSE SYSTEM

Based on the IT-CMF, the proposed IA-orientated CMF in Figure 1 was outlined to guide our discussion with domain of emergency service providers. The need for integrate information sharing system for such inter-organizational service is identified. This led to the development of the proposed framework. The resulting maturity levels address the aspect of information sharing integration, especially from socio-technical approach. IA, as indicated in IA definition, it contains information relationship (structure: *information structure* and *information network*), information elements (content: *information structure* and *information governance*), as well the management and information sharing (behavior: *information exchange* and *information governance*).

Construction of the IA-CMF model

Following the construction of IT-CMF, the proposed framework for information sharing assessment from IA perspective consists of four categories. Each category is composed of components, which define measurable attributes to assess maturity of a category. Based on META Group (Christiaens et al., 2010), information maturity models (IMM) should consider key concepts such as data quality, information architecture, information governance, information usage, metadata, and information infrastructure. Taken META group’s proposed IMM into consideration with adaption of the Federal Enterprise Architecture (FEA) Data Reference Model (DRM), we outline the IA-orientated CMF. Emergency service is perceived as one single enterprise consists of multiple organizations. The maturity level of information sharing based on the enterprise integration level. Considering the above described IA characteristics, we structure the framework along these categories (Figure 1). We develop each category with some key indication for capability and maturity assessment.

Maturity		Information Structure (Semantics)	Information Network (Technology)	Information Exchange (Process)	Information Governance (Management)
High	5 Optimising	<ul style="list-style-type: none"> Enterprise-level information structure monitoring with effectiveness in terms of collaborative impact on end-to-end performance. 	<ul style="list-style-type: none"> Enterprise-level infrastructure model supports end-to-end information sharing Quantified business Value at Risk drives technical resource reallocation. 	<ul style="list-style-type: none"> IQ enhanced information exchange processes aligned with end-to-end business processes demands 	<ul style="list-style-type: none"> Enterprise-level project for information sharing architecture is well established Value added management for end-to-end performance
	4 Advanced	<ul style="list-style-type: none"> Structured monitoring of information structure-enabled end-to-end service with taxonomies, metamodel, and information mapping 	<ul style="list-style-type: none"> Current/projected demand from end-to-end service drives information sharing technologies Value at Risk projected across future time intervals for each investment 	<ul style="list-style-type: none"> Structured monitoring of IQ emphasized end-to-end information exchange processes with each process regulated with the accessibility procedure 	<ul style="list-style-type: none"> Assigned authorities ensure the information sharing is well architected Managing the information sharing project to improve service
	3 Intermediate	<ul style="list-style-type: none"> Structured developing of between organizations information taxonomies, models, and structured standard information elements. 	<ul style="list-style-type: none"> IT applications applied between organizations Planned infrastructure, to support shared services based on need Risk assessment within organization-level 	<ul style="list-style-type: none"> Primary IQ set is emphasized for information exchange process Information accessibility procedure is established between organizations. 	<ul style="list-style-type: none"> Assigned authorities monitor between organization level information sharing Management project established based on information sharing needs
	2 Basic	<ul style="list-style-type: none"> Structuring individual components (information elements, IS model etc) with trended development in terms of structure metrics 	<ul style="list-style-type: none"> Primary applications are used Rudimentary component-specific capacity planning for service Risk assessment limited to individual component failure 	<ul style="list-style-type: none"> Information accessibility procedures established for necessary information requested cross organizations 	<ul style="list-style-type: none"> Authority oversights component-specific IS for information management Information sharing project developed within organizations
	1 Initial	<ul style="list-style-type: none"> Focus on individual information asset monitoring with no consideration on consistence of taxonomies, metamodel. information response is reactive) 	<ul style="list-style-type: none"> No linkage of infrastructure with service providing No capacity planning for shared services No risk assessment 	<ul style="list-style-type: none"> No defined procedures for information share and exchange No specific focus on IQ dimensions for the information exchange process 	<ul style="list-style-type: none"> No certain authorities oversight the information sharing regulations Management has limited concern on information sharing projects
Low					

Figure 1. The IA-oriented CMF

Information Structure (Semantics): As defined, IA can be deemed as blueprint emphasizing the key information elements and their relationships among the information elements. Semantically mapping the information flow allows us to trace the information elements change while being shared cross organizations. It is measured from components of Information taxonomies and vocabularies, Information metamodel, and Information mapping.

Information Network (Technology): Well structured information relationship among organizations fundamentally supports information sharing for effective response. Components derived are Technical resources, Information sharing services, Repositories. Information network relation to the capability to drive information integration is assessed, by enabling information flow and interaction cross- organizations. It also addresses the scope of applications, by the adoption of technical resource (devices, equipments, software etc.).

Information Exchange (Processes): Information sharing strongly depends on how information exchange processes are managed across organizational boundaries. Information exchange has to be aligned with the response processes for service delivery. Components are Information sharing processes and Information quality.

Information Governance (Management): Without an enforcement mechanism in place to clarify the operational ownership of information, the accountability for quality will be a barrier. Also, how well the information sharing structure, network, and processes are established and managed is assessed by the governance, which addresses not only technical aspects but also IS-related issues such as compliance with standards in policies and procedures. Information governance, Ownership of information, and program governance are the components.

CASE STUDY-EMERGENCY RESPONSE SYSTEM IN DUBLIN, IRELAND

Information Sharing Maturity Assessment

To instantiate the above devised framework, we carried out an assessment with the emergency response units in Ireland. One-on-one and group interviews with relevant staff, field visits, and initial results discussion were conducted. We model the emergency crisis response to assist the assessment analysis, show in Figure. 2.

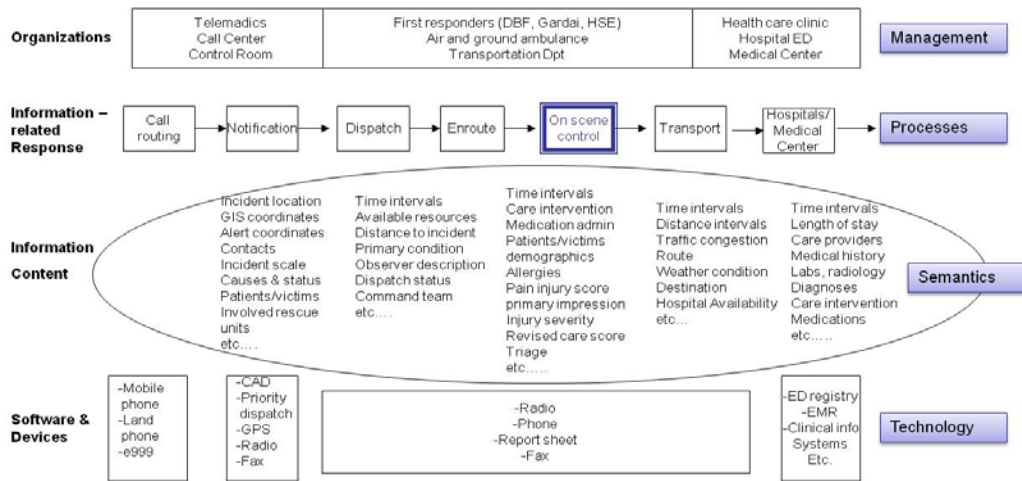


Figure 2. Emergency response overview in Ireland

Findings

According to the discussion and analysis, we indicate that their IA maturity level is in range three.

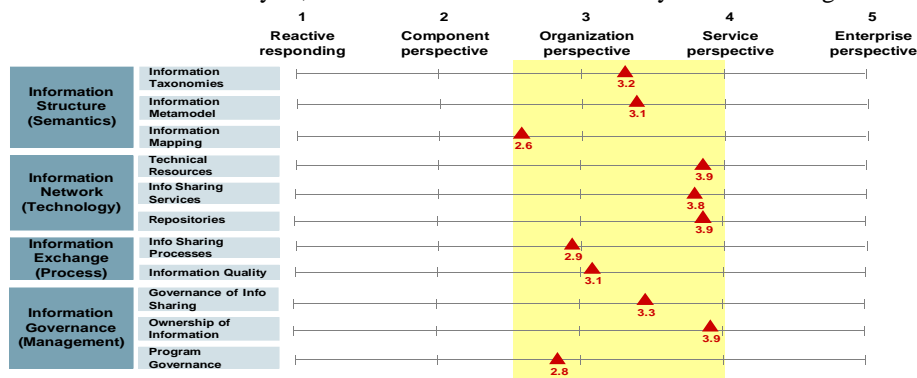


Figure 3. Initial IA maturity level assessment results

Information Structure: most of the organizations/units established database with defined taxonomies and metamodel, but only control room and ambulance unit share the same information structure. No unified information standards seen from end-to-end service view, nor emergency response as a single united enterprise.

Information Network: The control room and ambulance units share the technology and system. The IT plan are consistently carried out, including installing and updating IT infrastructures, risk assessment, and training program. But all the communication outside (hospitals, Gardai etc.) is based on written forms, radio and phones.

Information Exchange: Information sharing processes are not well defined or regulated, only individual organization-level information exchange is focused. Information quality addresses accuracy and timeliness, but no consistent monitoring for IQ during the processes.

Information Governance: Health Information and Quality Authority (HIQA) and Pre-Hospital Emergency Care Council (PHECC) are the major authorities to oversight the information system and regulation. But they are separate entities that monitor the information system (IS) of dispatch center and pre-hospital care IS. Very well defined the owners support information services. The control room and dispatch center usually train as one unit and they sharing knowledge and information closely.

CONCLUSION

In this article, towards an IA-orientated framework was presented to assess and advance information sharing for emergency response system. It addresses and supports information efficiency of a complex socio-technical system which is highly rely on information and timely response. Despite its application being limited to a emergency response context and a limited evaluation design results, the presented IA-oriented CMF contributes to the knowledge base and addresses the problem space by identifying relevant categories and capability building blogs that determine maturity of information architecture for EMS professionals. This enables development of methodological framework to assess current state and give directions on advancing information sharing cross organizations based on accepted models for maturity assessment.

We illustrate how and why this proposed framework is devised, followed a case as example. In order to develop a method to improve the maturity level, future research and evaluation of this designed framework is required. An enhancement of the case-study driven profile will enable improvement of the IA-oriented CMF for both assessment and improvement guidelines.

REFERENCE

1. Brandeau, M. L., Sainfort, F., Pierskalla, W. P., Henderson, S. and Mason, A. (2005) Ambulance Service Planning: Simulation and Data Visualisation, *Operations Research and Health Care*, 70 (Ed, Hillier, F. S.) Springer US, pp. 77-102.
2. Christiaens, S., Leenheer, P. D. and Moor, A. d. (2010) Information Maturity in Large Organisations through Business Semantics: A Business Case at the Flemish Public Administration, *META Group Report*.
3. Curley, M. (2004) Managing Information Technology for Business Value, *Intel Press*.
4. Evernden, R. and Evernden, E. (2003) Third-Generation Information Architecture, *Communications of the ACM*, 46, 95-98.
5. Gnter Ropohl, U. and Gunter, R. (1999) Philosophy of Socio-Technical Systems, Springer.
6. Hevner, A. R., March, S. T., Jinsoo, P. and Ram, S. (2004) Design Science in Information Systems Research, *MIS Quarterly*, 28, 75-105.
7. James, C. B., Larry, S. and Salvatore, T. M. (1989) Building and Implementing an Information Architecture, *SIGMIS Database*, 20, 9-17.
8. Paulk, M. C. (1993) Key Practices of The Capability Maturity Model Version 1.1, Research Access for Software Engineering Institute, Pittsburgh, PA.
9. Plsek, P. E. and Wilson, T. (2001) Complexity, leadership, and management in healthcare organisations, *BMJ*, 323, 746-749.
10. Rosenfeld, L. and Morville, P. (1998) *Information Architecture for the World Wide Web*, O'Reilly Associates, Inc.
11. Schooley, B. and Horan, T. (2007) End-to-End Enterprise Performance Management in the Public Sector through Inter-organizational Information Integration, *Government Information Quarterly*, 24, 755-784.
12. Van De Ven, A. H. and Poole, M. S. (1995) Explaining Development And Change in Organizations, *Academy of Management Review*, 20, 510-540.
13. Wiederhold, G. (1992) Mediators In The Architecture of Future Information Systems, *Computer*, 25, 38-49.
14. Wurman, R. S. (1990) *Information Anxiety*, New York.
15. Zachman, J. A. (1987) A Framework for Information Systems Architecture, *IBM Systems Journal*, 26, 276-292.