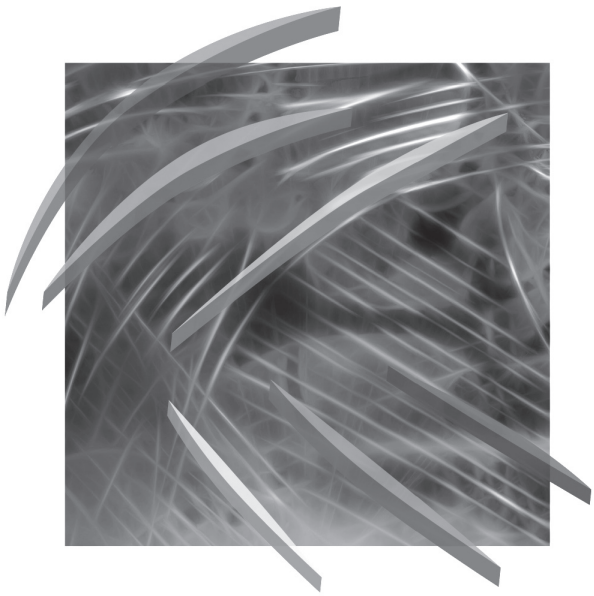
# INFORMATYKA EKONOMICZNA
## BUSINESS INFORMATICS

21 • 2011



Publishing House of Wrocław University of Economics
Wrocław 2011

Copy-editing: Agnieszka Flasińska, Elżbieta Macauley, Tim Macauley,

Layout: Barbara Łopusiewicz

Proof-reading: Barbara Cibis

Typesetting: Małgorzata Czupryńska

Cover design: Beata Dębska

This publication is available at www.ibuk.pl

Abstracts of published papers are available in the international database The Central European Journal of Social Sciences and Humanities http://cejsh.icm.edu.pl
and in The Central and Eastern European Online Library www.ceeol.com

Information of submitting and reviewing papers is available on the Publishing House's website www.wydawnictwo.ue.wroc.pl



**ISSN 1507-3858** (Business Informatics)
**ISSN 1899-3192** (Research Papers of Wrocław University of Economics)

The original version: printed

Printing: Printing House TOTEM
Print run: 200 copies

## Contents



## Streszczenia

INFORMATYKA EKONOMICZNA BUSINESS INFORMATICS 21 • 2011

ISSN 1507-3858

**Shuyan Xie, Markus Helfert**
Dublin City University, Ireland
{shuyan.xie, markus.helfert}@computing.dcu.ie

# INFORMATION ARCHITECTURE AND PERFORMANCE – DEMONSTRATED WITHIN THE EMERGENCY MEDICAL SERVICES

**Abstract:** The paper contributes to the ongoing discussion of the relation between information system and organizational performance. This paper examines the relation between architecture guiding the development and the use of information support systems that maintain the performance of time critical services. Our work is based on the IT-Capability Maturity Framework (IT-CMF), a novel IT management maturity model. We detail some aspects of this model from an information architecture perspective and examine a country wide emergency service system (EMS), providing a collection of characteristics meant to guide an emergency response system toward a high level of operational performance. We propose an outline of a framework for analyzing architectural aspects that can help to improve emergency response systems.

**Key words:** information system, information architecture, medical services, emergency service system, IT capability maturity framework.

## 1. Introduction

In responding to an emergency, a variety of actors and resources are involved forming a complex emergency service system. Actors include for example official agencies, fire and rescue services, the police services and the emergency medical services, as well as actors from the private sector and non-profit organizations. Such a system of actors and resources, known as emergency response system [Uhr, Johansson, Fredholm 2008], can be regarded as a complex socio-technical system [Ropohl 1999]. It involves elements of both social (individuals, actors, groups, organizations, etc.) and of technical nature. Information systems used by emergency response personnel must provide information anywhere and anytime it is needed, in a form and format that avoid "overload and misuse" and supports the "coordination of efforts of a great number of organizations and individuals" [Zwass 2003]. Despite its importance, much of the research to date has focused on the relationship between Information Technology (IT) systems and business operations (Melville, Kraemer, Gurbaxani 2004; Mooney, Gurbaxani, Kraemer 1996; Irani 2002; DeLone, McLean

1992) information aspect, information quality and information management for example, as key determined of operation and performance has been often neglected however. Furthermore, several studies have highlighted the importance of either technology management or the organizational management [Melville, Kraemer, Gurbaxani 2004], however, very limited research considers both technical and behavioural perspectives in order to examine complex information systems (IS) and its impact on performance.

In order to address these limitations, the paper explores the impact of information on the operational performance of inter-organizational services. Based on the Information Technology-Capability Maturity Framework (IT-CMF) (www.ivi.ie), we analyze the impact from an information architectural view point. While several researchers have presented frameworks and heuristics for conceptualizing, designing, managing, and analyzing emergency information systems (e.g. [Laudon, Laudon 2002; Dwarkanath, Daconta 2006; Sowa, Zachman 1992], there is a need to investigate the underlying architectures for guiding the development and use of enterprise information for time critical contexts. Such an approach would need to be context specific to emergency response, include understanding of information use from technological and sociological perspectives. To extend this notion and to manage information from socio-technical aspects we propose an information architecture (IA)-oriented framework, that maps underlying information structures and relationships to support assessment and analysis for guiding multi-organizational enterprise performance.

For this study, the organizations involved include the control centre which initially takes the information and makes rescue decisions of a major emergency responder in Ireland, the emergency responders (e.g. national ambulance centres, ambulance companies) and hospitals. The patient-focused service chain for the EMS system is initiated at the time an emergency call ("9-9-9 call") is made, continues through dispatch, response, field care, and patient delivery to a care facility, and ends with patient treatment and discharge. The services are extremely time and information critical in nature and require coordination and information exchange between and across each of the organizations [Schooley, Horan 2007]. In this sense, Information architecture (IA) allows to visualize the analysis on real-time decision-making information, thus examine if information is provided in a timely manner to save lives, limit damage and accelerate recovery.

Recently several maturity frameworks related to the management of IT have been developed and used successfully in the IS industry [Becker, Knackstedt, Pöppelbuß 2009; Johannsen, Goeken 2007]. There are many detailed frameworks such as ITIL and COBIT. In contrast to select one particular framework, in our work we follow the Information Technology-Capability Maturity Framework (IT-CMF) due to its overarching character and its focus on capabilities [Curley 2004, 2006]. The IT-CMF interfaces with other prominent frameworks. It also provides a reference model in the form of maturity levels and assessment techniques for IT management processes.

Furthermore, it assists organizations in improving IT management capability and thus organizational performance. It categorized critical processes along four macro processes and includes five maturity levels that are used to assess levels of maturity in the IT organization. The IT-CMF is structured along 32 critical processes, of which one addresses aspects of Enterprise Architecture Management (EAM). Within this process the need and value of IA is emphasized. In this sense, Enterprise Architecture is a pre-courser for the design and enforcement of the integration of disparate organizations.

In the context of an EMS, IT Management and particular Enterprise Architecture may be challenging, as often authority that provides oversight and performance improvement does not always have direct control over all the organizations [Roses, Weill 2006]. The EMS authority is required to co-ordinate multiple independent units to provide end-to-end inter-organizational services. In order to help addressing this challenge and motivated by the relevance and importance of IA within the IT-CMF, we adapted the framework and developed detailed capabilities to manage and maintain IA, from both a technical and social point of view. This is designed to drive the EMS enterprise "away from inherent business silos and towards greater levels of standardization and integration of information and technology across all stakeholder groups" [Schooley, Marich, Horan 2008. Following the IT-CMF we categorize five general stages of information architecture maturity. A greater maturity level indicates a more sufficient usage of information, and thus the higher the likelihood of performance enhancements.

Applying our inter-organizational and information focused framework this paper demonstrates within EMS how a multi-organizational system is able to examine information related processes. Our work resulted in defining information architectural qualities that could be used to drive the EMS enterprise to a higher level of IA maturity. In contrast to centring on individual performance concerns of each organization, our work shows that a higher level of integration of information across all the organizations would be beneficial and may be achieved.

The reminder of the paper is structured as follows: Section 2 outlines the research methodology. Related work is discussed in section 3. Section 4 presents our information architecture oriented framework, which is then used within a case described in section 5. We conclude our paper in section 6 by summarizing the main contributions together with some remarks for further research.

## 2. Methodology

Grounded in design science [Hevner et al. 2004; Carlsson 2010; March, Smith 1995; Peffers et al. 2007], this study combines literature review and case study research in order to develop an IA-oriented framework. This forms the basis to examine the impact of IA on operational performance. Literature is used as the primary data source in this paper. One reason for using literature as the basis for our framework is

that literature is accessible, in consideration of the effort, cost, and speed of primary data gathering. Besides, literature provides an excellent range of various perspectives that otherwise might be unattained (including enterprise architecture, information architecture, emergency medical service and response system, data communications, and inter-organizational information systems and performance). The data can be collected, analyzed, and incorporated with interview or observational data.

Secondary source data is based on examining a case of an emergency response unit in Ireland. It includes the results of a previous analysis and interviews with domain experts and field visits. The questions asked probed the difficulties faced by the crisis handling team during crisis response, support tools, the effectiveness of these tools, as well as the supporting information architecture and system for crisis management.

## 3. Related work

Information sharing, and in particular, real-time and relevant information provides the basis for a better and efficient response to emergencies, and thus helps to save time and lives. As a result, a significant challenge exists in these fast-paced environments in terms of collecting and handing-off accurate and timely patient information from one care provider to the next [Quarantelli 1988].Consequently, there is a significant need for information-centric process improvement initiatives and guiding frameworks for streamlining information hand-offs to improve the performance. From an IA perspective, an integrated information flow should improve the inter-organizational emergency environment. Indeed, during an emergency or crisis, clear information analysis and decision making need to be available in a timely manner while unexpected events and additional parties are involved. Examining IA, we aim to address and provide guidelines for assessment and improvement from an information perspective. An outline for this research context is illustrated in Figure 1.

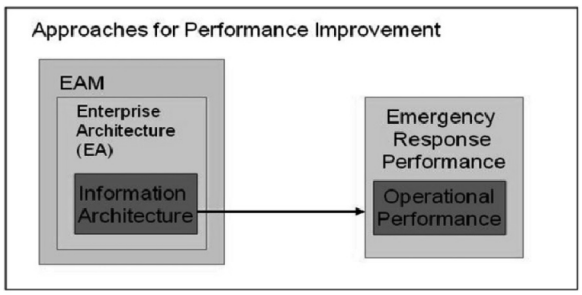



**Figure 1.** Research context

### 3.1. Information Architecture (IA)

Information Architecture has been described from various viewpoints. R.S. Wurman [1990], who coined the term "information architecture", highlights that IA is directed towards (1) "the individual who organizes the patterns inherent in data, making the complex clear." (2) "A person who creates the structure or map of information which allows others to find their personal paths to knowledge."

L. Rosenfield and P. Morville [1998] took a multi-perspective approach to define IA, and focus on aspects of web design: "The structural design of shared information environments" is highlighted as the structural purpose of IA. They also describe IA, from a functional purpose, as "the art and science of shaping information products and experience to support usability and find ability" [Rosenfield, Morville 1998]. Within the internet age, they view IA as an emerging discipline and community of practice focused on bringing principles of design and architecture to a digital landscape.

Following the discussion above together with G. Wiederhold's [1992] work, we conclude that an emphasis on the data structure is present. However, these contributions often neglect the behaviour perspective important to architectures [Foegen, Battenfeld 2001; Zachman 1987] and how information is used and exchanged among actors/users. Both views are important due to its practical usage of information and therefore in our work we consider both aspects, static and dynamic. Subsequently we define IA as a representation of the structural and behavioural aspects of relevant information elements within an information system. IA includes the relationships between information elements (static view) as well as the information usage and exchange among various actors (technical and human) in an enterprise (dynamic view).

### 3.2. Capability maturity framework

In order to examine the relation between information architecture and performance, we frame our work within the context of maturity models as they provide a vehicle to relate IT to organizational performance. Several maturity models related to information management have been proposed [Becker, Knackstedt, Pöppelbuß 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. Prominent maturity models describe in detail assessment approaches, however they are often limited in providing guidelines on how to improve maturity levels. Together with the Innovation Value Institute (IVI) over the last years the IT-CMF was developed and disseminated [Filipe et al. 2009; Curley 2004, 2006; Donnellan, Helfert 2010]. The IT-CMF maturity model provides reference models in the form of maturity levels and assessment techniques, in addition to indicators to improve the current situation.

The IT-CMF views maturity models from two aspects, one capturing the assessment of the current status and the other guiding organizations towards higher maturity levels. Maturity evolves then, through a progression of levels or stages that apply the life cycle theory [Van De Ven, Poole 1995] with transformations over time. As such, in considering inter-organizational services and the objective of improving IA, we selected the IT-CMF in our research.

## 4. IA-Oriented Framework for Emergency Response Systems

Based on the IT-CMF the proposed IA-oriented framework (IA-CMF) was developed to guide our discussion with domain experts of EMS providers. During the initial discussions, we confirmed the need mentioned in literature for an integrated information system for inter-organizational services within the EMS [Drake, Steckler, Koch 2004]. From the literature review, we summarized the academic and empirical groups work on the relevant components that related to the integrated data and information system. Opinions from EMS professionals and the related research led to the development of the proposed framework.

| Category | Capability building block | Description |
|---|---|---|
| Information Structure (Semantics) | Information taxonomies and vocabularies | Address the extent to which knowledge and information taxonomies and vocabularies are defined, agreed upon and used to support information sharing initiatives within and among organizations. |
| | Information metamodel | Identifies which information metamodels and metadata repositories have been defined and how they are being used to support information sharing initiatives within and among organizations. |
| | Information mapping | Display the required information elements under situation, and positioning the information flow changes . |
| Information Network (Technology) | Technical Resources | Evaluate the devices and software programs allow better information sharing and exchange under situations. |
| | Shared services | Evaluate the extent to which shared components and services support information sharing and the reuse of these components and services. |
| | Repositories | Evaluate the maturity of organization's information repositories with regard to supporting the tasks. |
| Information Exchange (Processes) | Information sharing processes | Look at the degree of sharing of information assets dynamically and how they are defined in a systematic manner and being improved within and among organizations. |
| | Information quality | Examines information quality presence during the information exchange processes crcoss organizations |
| Information Governance (Management) | Governance of information sharing | Identifies an enterprise-level over sighting authority for managing information sharing regulation and standards. |
| | Ownership of information | Evaluates the degree to which information ownership or stewardship is clearly defined and whether those owners or stewards support information sharing activities. |
| | Program governance | Evaluate the maturity of program governance processes within and among organizations for managing information sharing projects, initiatives and programs. |

**Figure 2.** The information architecture oriented framework

Source: [Xie, Helfert 2010].

The resulting maturity levels of the devised IA-CMF are focused on aspects of integration. IA, as indicated when defining IA, contains information elements (content), information relationships (structure), as well as usage and information exchange (behaviour). In Figure 2 we structure the devised IA-CMF for inter-organizational services along these dimensions. In order to manage information architectures the framework provides the assessment techniques together with methods to improve the ability to perform. We develop for each dimension some key indication for capability and maturity assessment.

– From a structural perspective we include information structure and information network.
– From a content perspective, we focus on data quality and information usage and development.
– From a behaviour perspective we include usage and development, which focuses on value when IA is been used and continuously developed.

As defined, IA can be deemed a blueprint emphasizing the key information elements and their relationships among the information elements. Today's organizations are faced with dynamic and turbulent environments that require a quick and adaptive response. Well organized information relationships among the organizations fundamentally support the performance under a crisis situation. The way how information evolves and is connected provides a path to trace a complex information relationship within and across information networks (devices, equipment etc.) [Zachman 1987], which allows us to analyze the integration of the information content. Data Quality (DQ) is chosen as an important lens in which we view IS from an output perspective for IA. Here we follow the concept of information manufacturing systems that produces information products of which quality can be measured [Pham Thi, Helfert 2007]. DQ guarantees the effectiveness of the architecture being designed and used.

## 5. Case study – emergency response system in Dublin, Ireland

One of our goals of the research is to provide a practical usable framework. In order to show its practicality we developed and applied the proposed framework within an EMS setting in Dublin. In addition to this case study, we also had the opportunity to review related information from a previous project with an emergency response unit in Dublin. We used observation, documentation plus additional reports from the Health Information and Quality Authority (HIQA) as well as one-to-one interviews and group interviews, discussion with relevant staff, and field visits. The initial results are very promising and indicate that our IA framework is feasible providing valuable insight into the information exchange. We focus on three aspects related to the EMS system. (1) Information and IT usage related to pre-hospital sector; (2) Information and IT relevant to the hospital sector; (3) Information and IT implementation associated with performance measurement and management across the continuum

of patient care. In order to elicit responses related to the activities of EMS personnel and to gain insight into the information, we also observed performance related data. Through identification of the information that occurred during the patient transfer between organizations, we were able to gain valuable insights on how information architecture could potentially facilitate a more effective EMS performance.

### 5.1. Case setting

The county's EMS has a unique combination of fire department and ambulance services. The Health Information and Quality Authority (HIQA) is an independent authority that is responsible for quality and performance across EMS organizations including 9-9-9 control room, fire services, ambulance services, and health care facilities. Within this role the HIQA strives to find ways to use information for an integrated service performance and on behalf of the citizen. Dublin has private contractors that supply a number of services, such as the air and ground ambulance services. The EMS system in Dublin has been innovative in some key areas distinguishing itself as an early system integrator, pushing data about emergency incident from computer aided dispatch (CAD) system to emergency responders, or to their patient care records (PCR) systems. A priority dispatch system has been integrated into the CAD system since 2010. The county's propensity towards organizational integration provides a valuable case to examine the migration towards higher levels of information integration. The central challenge that HIQA faces is that they do not have direct control over any of the aforementioned service organizations. They work through their enforcement of a performance standards and regulations. Although Pre-hospital Emergency Care Council (PHECC) is established for pre-hospital information system management, challenges to ensure information sharing with hospital personnel are still before them. In essence, the authority mandates certain levels of training for personnel, compliance with designated emergency response times, health care provision protocols. This essentially aligns the EMS organizations with large-scale EMS visions and goals. Furthermore, due to the information critical characteristic, the authority explores ways to use information in order to increase performance.

### 5.2. Findings

The proposed IA-CMF was presented to relevant personnel in HIQA as a means to drive the discussions regarding the EMS processes as well as to understand the role of IA with respect to the operational view. The initial discussions yielded a total of four significant findings. These findings, as discussed below, were focused on operational performance for complex socio-technical systems. At the operational level, the discussion confirmed that an understanding of how information flows throughout the EMS system process is necessary.

**Pre-hospital and hospital gap:** Although the authority currently uses performance measurements and tools, the ability to use information in a full range of pre-hospital and hospitals in terms of system performance and health outcomes is not yet fully realized. This is due to the focus on individual environments. While the pre-hospital system has made strides to integrate and share information between the control room, dispatch, and ambulance crew, each hospital still needs to continue to maintain the entire information. What happens on the pre-hospital side is often not well known to those who operate within the hospital side.

**System usability:** Over the years, the EMS personnel have strived to improve system usability. While much has been done, there still remains a challenge for designing a more user-friendly interface to collect and resend information within the emergency context. As one of the EMS director commented on ease of use: "It takes too much time and effort to go to a computing terminal/paper charts to send/retrieve that emergency medical information." Using IA to understand information usage, we hope to simplify the system usage and present a clear path for information sharing.

**Unified patient information:** While there are systems in place to track data regarding incident and patient, an integrated patient record has not yet been achieved. For the overall service performance, they need better access to accurate and relevant information about what happened as the patient information goes throughout the EMS system. Sometimes the clinical personnel have no option to ensure which patient went to which facility. Obviously this is hugely confounding during a major incident. Therefore, the quality of information needs to be enhanced.

**Data quality:** While there are information sharing requirements and standards for storing data and data sharing, the EMS authority has not yet addressed the end-to-end inter-organizational perspective of these standards, especially real-time information exchange and communication. The domain expert comments that data monitoring systems were long overdue, especially when paramedics communicated with the care facilities. They also stressed the importance of data quality for interoperability between information systems.

### 5.3. Suggestions

Examination of the findings confirmed that the quality of information architecture could enable high-performance measures to achieve the desired level of the county's emergency medical services. Participants discussed that a complete view of incident information is required to better understand the end-to-end performance. There would be a need to retrieve data from a wide range of existing organizations and information systems. After analyzing the current situation with our IA framework, we also provided some recommendations that are summarized in Table 1.

Subsequently based on our results we derived characteristics of high and low performing IA architectures. These profiles aligned to operational performance are outlined in Figure 3 and structured along the four dimensions (Information Structure,

**Table 1.** Recommendations for maturity level improvement

| | |
|---|---|
| Information structure | Information types, objectives and layout should be well structured and viewed as end-to-end system, an integrated and overall picture of the information exchange. Open web systems should be considered, e.g. rather than waiting for a paramedic to click the "submit report" button, patient information would be dynamically instantly sent to the care providers at a receiving ED. |
| Information network | Problem of timely response is identified: (1) Identifying the right location for victims/patients treatment. (2) On scene coordination among all the teams. In order to build clear network for information exchange and sharing especially under crisis, it is necessary to introduce some advanced software such as Hospital Availability System that available facilities and care providers can be instantly captured by the commander teams. Open systems and web service can be adapted. |
| Data quality | Situational profiles can be created for all the involved organizations. Prioritized data set should be introduced based on situations. E.g. communication between ambulance crew and ED physicians, timeliness, conciseness, and understandability should be emphasized more in the profile, and accordingly provide instructions of what/when/who/how to present the quality data in relevance. |
| Usage and development | Additional to the managed IS, the emergency response units should be use and develop information management with consideration of architecture roles and value, such as how elements of information systems interrelate and behave, how information is stored and processed, and how people are organized to build, maintain the system. Architectures provide the fabric necessary to enable innovative, effective, and productive use of IT IS. |

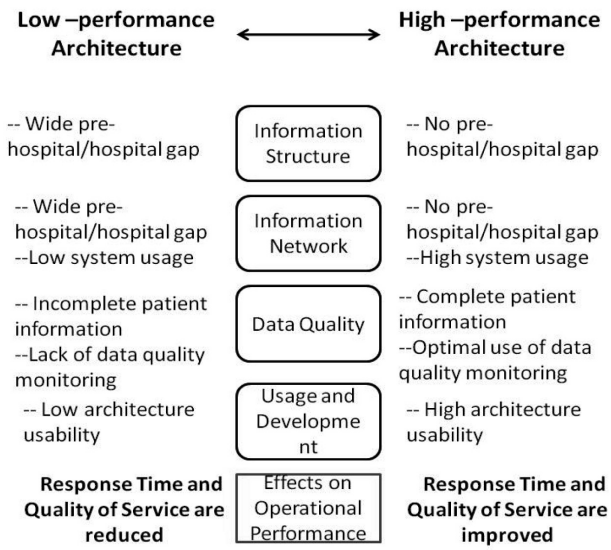



**Figure 3.** IA qualities that affect operational performance

Source: adapted from [Schooley, Horan 2007].

Information Network, Data Quality, and Usage) of the IA-CAMF. For example, the first quality indicator shows a wide gap of information sharing between "pre-hospital" and "hospital" which results in low-performance. Similarly, other indicators can be aligned, as illustrated in the findings section above. This work of identifying IA profiles and patterns resulting in low and high operational performance will be subject to further research by which we expect to provide a valuable guideline to organizations.

## 6. Conclusions

The main contribution of this paper is a framework for analyzing and improving complex multi-organizations emergency response system. We showed that information architecture helps to organize the information related to crisis situations, providing an integrated information exchange and network for information usage. Our approach is framed within a socio-technical perspective and follows an IA-oriented maturity framework to guide the strategic direction of the multi-organizational EMS systems. We presented the findings within the context of the IT-CMF, and subsequently we indicate the architectural approach to improve operational performance. Further agreement and refined performance features are needed from relevant authority groups. It would be valuable to conduct a more in-depth study into the few EMS systems in Ireland and elsewhere that has implemented effective information management and can demonstrate the benefits. To sum up, the IA-oriented framework served as a tool to help define the multiple-organizational information architecture desired by the key EMS stakeholder groups. While IT deployment in itself will not ensure optimal collection and transfer of patient information in a timely manner, there is an important parallel criteria that should be applied, that is information management from IA perspective to ensure the structural, content and behavioural aspects. Our research at present provides a valuable framework, however in further research we aim to refine and validate the framework. The paper provides direction of information architectural aspects to assess and guide the multi-organizational EMS system to move towards a more integrated and standardized inter-organizational information architecture, in consideration of improving performance.

## References

Becker J., Knackstedt R., Pöppelbuß J., Developing maturity models for IT management – A procedure model and its application, *Business & Information Systems Engineering* 2009, Vol. 1, No. 3, pp. 213–222.

Carlsson S.D., Design science research in information systems: A critical realist approach, [in:] A. Hevner, S. Chatterjee (Eds.), *Design Science Research in Information Systems: Theory and Practice*, Springer, New York 2010.

Curley M., *Managing Information Technology for Business Value*, Intel Press, Hillsboro, OR, 2004.

Curley M., The IT transformation at Intel, *MIS Quarterly Executive* 2006, Vol. 5, No. 4 (1), pp. 109–122.
DeLone W.H., McLean E.R., Information systems success: the quest for the dependent variable, *Information Systems Research* 1992, Vol. 3, No. 1, pp. 60–95.
Donnellan B., Helfert M., The IT-CMF: A practical application of design science, [in:] R. Winter, J.L. Zhao, S. Aier (Eds.), *DESRIST 2010*, LNCS 6105, pp. 550–553, Springer.
Drake D.B., Steckler N.A., Koch M.J., Information sharing in and across government agencies, *Social Science Computer Review* 2004, Vol. 22, No. 1, pp. 67–84.
Dwarkanath S., Daconta M., Emergency services enterprise framework: A Service-Oriented Approach [in:] *Proceedings of the 3rd International ISCRAM Conference*, Newark, NJ (USA), 2006.
Filipe J., Cordeiro J., Cardoso J., Curley M., Introducing an IT capability maturity framework, [in:] W. Aalst, J. Mylopoulos, N.M. Sadeh, M.J. Shaw, C. Szyperski (Eds.), *Enterprise Information Systems*, Springer, Berlin–Heidelberg 2009.
Foegen M., Battenfeld J., Die Rolle der Architektur in der Anwendungsentwicklung, *Informatik Spektrum* 2001, Vol. 24, No. 5, pp. 290–301.
Hevner A.R., March S.T., Jinsoo P., Ram S., Design science in information systems research, *MIS Quarterly* 2004, Vol. 28, No. 1, pp. 75–105.
Irani Z., Information systems evaluation: navigating through the problem domain, *Information & Management* 2002, Vol. 40, No. 1, pp. 11–24.
Johannsen W., Goeken M., *Referenzmodelle für IT Governance*, dpunkt.verlag, Heidelberg 2007.
Laudon C., Laudon P., *Management Information Systems: Managing the Digital Firm*, Prentice Hall, Englewood Cliffs, NJ, 2002.
March S.T., Smith G.G., Design and natural science research on information technology, *Decision Support Systems* 1995, Vol. 15, No. 4, pp. 251–266.
Melville N., Kraemer K., Gurbaxani V., Review: Information technology and organizational performance: An integrative model of IT business value, *MIS Quarterly* 2004, Vol. 28, No. 2, pp. 283–322.
Mooney J.G., Gurbaxani V., Kraemer K.L., A process oriented framework for assessing the business value of information technology, *ACM SIGMIS Database* 1996, Vol. 27, No. 2, pp. 68–81.
Paulk M.C., *Key Practices of the Capability Maturity Model Version 1.1*, Research Access for Software Engineering Institute, Pittsburgh, PA, 1993.
Peffers K., Tuunanen T., Rothenberger M.A., Chatterjee S., A Design Science research methodology for information systems research, *Journal of Management Information Systems* 2007, Vol. 24, No. 3, pp. 45–77.
Pham Thi T.T. Helfert M., Modelling information manufacturing systems, *International Journal of Information Quality* 2007, Vol. 1, No. 1, pp. 5–21.
Quarantelli, E.L., Disaster crisis management: A summary of research findings, *Journal of Management Studies* 1988, Vol. 25, No. 4, pp. 373–385.
Ropohl G., Philosophy of socio-technical systems, *Society for Philosophy and Technology* 1999, Vol. 4, No. 3.
Rosenfield L., Morville P., *Information Architecture for the World Wide Web*, O'Reilly Associates, Sebastopol, CA, 1998.
Ross J., Weill P., *Enterprise Architecture as Strategy: Creating a Foundation for Business Execution*, Harvard Business School Press, Boston, MA, 2006.
Schooley B., Marich M., Horan T., Understanding IT Governance in the San Mateo County EMS System, [in:] *Proceedings of the 5th International Conference on Information Systems for Crisis Response and Management (ISCRAM)*, Washington, DC, 2008.
Schooley B.L., Horan T.A., Towards end-to-end government performance management: Case study of interorganizational information integration in emergency medical services (EMS), *Government Information Quarterly* 2007, Vol. 24, No. 4, pp. 755–784.
Sowa J.F., Zachman J.A., 1992. Extending and formalizing the framework for information systems architecture, *IBM Systems Journal* 1992, Vol. 31, No. 3, pp. 590–616.

Uhr C., Johansson H., Fredholm L., Analysing emergency response systems, *Journal of Contingencies & Crisis Management* 2008, Vol. 16, No. 2, pp. 80–90.

Van De Ven A.H., Poole M.S., Explaining development and change in organizations, *Academy of Management Review* 1995, Vol. 20, No. 3, pp. 510–540.

Wiederhold G. (1992), Mediators in the architecture of future information systems, *Computer* 1992, Vol. 25, No. 3, pp. 38–49.

Wurman R.S., *Information Anxiety*, Bantam Books, New York 1990.

Xie S., Helfert M. Towards an Information Architecture Oriented Framework for Analyzing and Improving Emergency Response [in:] *Proceedings of the 8th International Conference on Information Systems for Crisis Response and Management (ISCRAM)*. Lisbon, Portugal. 2010.

Zachman J.A., A framework for information systems architecture, *IBM Systems Journal* 1987, Vol. 26, No. 3, pp. 276–292.

Zwass V., Electronic commerce and organizational innovation: Aspects and opportunities, *International Journal of Electronic Commerce* 2003, Vol. 7, No. 3, pp.7–37.

## ARCHITEKTURA INFORMACYJNA I JEJ WYDAJNOŚĆ NA PRZYKŁADZIE RATUNKOWEJ SŁUŻBY MEDYCZNEJ

**Streszczenie:** Artykuł dotyczy przeprowadzonej dyskusji odnoszącej się do relacji pomiędzy systemem informacyjnym a wydajnością organizacji. W ciągu ostatnich dekad zaproponowano wiele podejść i przeprowadzono wiele studiów, aby zbadać tę zależność. W artykule zbadane zostały zależności między rozwojem sterowanej architektury i wykorzystaniem systemów informacyjnych, które utrzymują wydajność w czasie dotyczącą krytycznych usług. W pracy odwołujemy się do IT-Capability Maturity Framework (IT-CMF), nowości w obszarze modeli dojrzałości zarządzania IT. Przedstawiamy pewne szczegóły modelu z perspektywy architektury informacji i badamy system ratunkowej służby medycznej (EMS), poprzez zbiór charakterystyk oznaczających wskazówki, jak ma odpowiadać system, zachowując wysoki poziom wydajności operacyjnej. Krytyczne w tym kontekście jest to, że sytuacje kryzysowe cechują się poważnymi konsekwencjami i bardzo krótkim czasem decyzyjnym. Proponujemy zarys metody do analizowania architektonicznych aspektów, które mogą poprawić czas odpowiedzi systemu. Studium przypadku ilustruje przedstawione rozwiązanie.

**Słowa kluczowe:** system informacyjny, architektura informacji, usługi medyczne, system ratunkowej służby medycznej, model IT CMF.