

PROCESS BASED INFORMATION SYSTEMS SUCCESS MODEL: ASSESSMENT OF THE INFORMATION TECHNOLOGY FUNCTION IN THREE HEALTHCARE ORGANISATIONS

Sevgi Özkan, Department of Information Systems, Informatics Institute, Middle East
Technical University, Turkey sozkan@ii.metu.edu.tr

Abstract

The effective use of information technology (IT) has the potential to solve problems efficiently, creating significant gains in performance and productivity. The medical sector is considered to be low level investors in IT when compared to other sectors. Many international comparisons look at the sums spent on health IT as a basis for determining how effective the IT systems are. However, this study supports the idea that this is a poor measure and a systematic approach needs to be taken when evaluating success of an IT system. A number of approaches for the evaluation of success of IT systems have been examined, and a novel model of IS effectiveness has been proposed. A process based assessment method (PB-ISAM) based on the proposed effectiveness model have been evaluated via three case organizations in the medical sector. Specific implications have been drawn concerning the applicability of an IS assessment approach in the context of the health sector.

Keywords: Information systems effectiveness, information systems evaluation, information systems success, information system process maturity, information technology management in medical sector.

1 INTRODUCTION

One of the top ten issues of information systems management is *measuring and improving information systems (IS) effectiveness* (Earl, 1989; Chang and King, 2005; DeLone and McLean, 2003, 2004; Myers, 2003; Seddon, 2002). In fact, information systems effectiveness has proven practically impossible to define and measure (Niederman, Brancheau and Wetherbe, 1991). There are many possible explanations for this difficulty. Evaluation, by its nature, is a very subjective undertaking which cannot be separated from human intellect, history, culture and social organization. The role of the information system in organisational performance can be subtle and difficult to differentiate from other factors (Nolan and McFarlan, 2005; Crowston and Treacy, 1986). Evidence suggests that poor performance of the information system is a serious inhibitor to good organisational performance. In addition, empirical research has shown that high information systems effectiveness is associated with high organizational performance (Chang and King, 2005). In that, assessment is an essential requirement of a feedback loop for continuous improvement of the information system and such improvement relates directly to the overall performance of the organization as measured by effectiveness. "Just as a human being needs a diversity of measures to assess his or her health and performance, an organization needs a diversity of measures to assess its health and performance" (Drucker, 1989). Systematic measurements are needed to guide action. "What gets measured gets attention" (Eccles, 1991). In parallel, DeLone and McLean (2003, 2004) emphasize the need for a validated measuring instrument of information systems effectiveness, which could provide a standardized evaluation mechanism enabling comparisons across departments, systems, users, organizations. They additionally assert that such a measurement will help building a cumulative research tradition which could clarify effectiveness measures. It is clear that information systems assessment is vital to organizations. Furthermore, organizations need a comprehensive framework for assessment to aid them in developing an information systems evaluation approach.

To present a more integrated view of IS effectiveness; this study aims to form a basis for developing a model that is believed to portray the manner IS effectiveness is assessed. The extensive survey of the relevant literature point in the direction of an integrated approach to the assessment of IS effectiveness. In that regard, individual assessment frameworks widely used in related areas such a software engineering and information technology (e.g. Capability Maturity Models [CMMs], Control Objectives for Information and Related Technology [CobiT], Information Technology Infrastructure Library [ITIL]) comply with the needs only partially. Therefore, although they yield convenient solutions in practice, they do not fulfill all of the necessities. The purpose of this research is to develop a comprehensive IS assessment framework using existing IS assessment theory as a base and incorporating theory from other disciplines. In conformance with the regard for the complementary nature of the fundamental frameworks in the literature, we propose an assessment model following the guidelines deduced from the literature collectively, with proper adaptations according to the needs and characteristics of the individual systems being assessed.

Taking into account that IS evaluation is an active and organization-dependent undertaking, this study proposes a novel conceptual model of IS effectiveness. In order to evaluate the proposed conceptual model, an assessment framework has been developed. Empirical evidence is sought through case study research, and the proposed process based assessment method has been applied on three organizations.

Economic/financial evaluation of information systems is intentionally left out of the scope of this study. While metrics such as return on investment (ROI) may successfully be used as surrogates for IS effectiveness measurement in certain cases, it is widely known that non-functional benefits are sufficiently well recognised to justify our choice of scope.

In short, this study includes a re-examination of the IS effectiveness assessment problem using methods of analysis contributed by (1) information systems research, (2) software engineering, and (3) information technology literature; yielding (a) a comprehensive, theoretically-derived, process based IS assessment method, (b) insight into the IS effectiveness field, (c) enhancement of IS assessment theory by incorporating ideas from empirical research, from a specific context, i.e. the medical sector, and (d) guidelines for the IS stakeholder (e.g. IS developer, user, or manager) on which information systems measures might best fit their organization. The fundamental contribution to the information systems body of knowledge is a comprehensive IS effectiveness assessment method that can be further tested for usefulness and applicability.

The remainder of the paper is organised as follows: In the subsequent section, a critical review of a number of approaches of evaluation related with IS effectiveness has been presented. Next, the IS effectiveness assessment framework has been described. Then, the empirical work where the proposed IS effectiveness assessment framework is applied in three case studies is described. Finally, the contributions and limitations of the research in both academic and practical terms are summarised. Based on these, issues for the utilisation of the research contributions in terms of potential future research topics have been addressed.

1.1 Effectiveness within the contexts of information systems, software engineering and information technology assessment

“IS success” may be considered as an emerging concept of “IS effectiveness” and “IS quality” (Özkan and Bilgen, 2003). Information system success depends on numerous circumstances, rather than a black-and-white formula. These systems are open systems so they are affected by the environment, and influenced by the people who use them. However, these systems are also goal-driven, so we can measure IS success by focusing on whether the system contributes to the achievement of the goals of the organisation.

It therefore appears that neither a purely subjective paradigm nor a purely functional one is adequate for understanding the effectiveness of the deployment of an information system. There is a wide spectrum within which the concept of effectiveness may be interpreted and the dimensions in which such an interpretation may be placed. Definitional and measurement issues have retarded the orderly and scientific accumulation of knowledge in this field.

Within the organisational context, many studies suggest that the efficacy of IS deployment has a great value to the organisation. Evidence also suggests that high IS effectiveness is associated with high organisational performance, which yields a connection between assessment and productivity. However on the "IS Quality" side, many studies show that both researchers' and practitioners' approach to information system quality is just like traditional approaches to software quality. However, it is evident that software quality is only limited to the development of software system, while IS quality is seen in the organisational context, where the use of software is stressed (Özkan, 2004; Özkan and Bilgen, 2003; Eriksson and Törn, 1991; Adelakun, 1991).

An important breakthrough in consolidating prior research was realized by DeLone and McLean (1992). They systematically combined individual measures from IS success categories to create a comprehensive measurement instrument. Their model rests on the foundations provided by the work of Shannon and Weaver (1949) and Mason (1978). This model is regarded as the most comprehensive IS assessment model within the body of IS research. DeLone and McLean (D&M) argue that when measuring IS success, researchers should "systematically combine" measures from their six IS Success categories. The Seddon Model (2002), conceptually elaborates and clarifies the aspects of the D&M model, thereby effectively integrating core theoretical relationships espoused in the literature. The creation of the D&M IS success model was driven by a process understanding of IS and their impacts. In addition, the success dimensions are interrelated, resulting in a success model that indicates that causality flows in the same direction as the information process.

Until recently, the practitioners and researchers in the general software engineering domain have considered and focused primarily to the quality of the artifact being developed, on the software (Vidgen, Wood-Harper and Wood, 1993; Eriksson and Törn, 1991; Adelakun, 1991; Garvin, 1987; Kallinikos, 2004; Dahlberg and Jarvinen, 1997; Özkan, 2004; Andersson and Von Hellens, 1997). This artifact, as a laboratory object, was analyzed and depicted usually away from its natural environment, the organizational context. Considering the quality of software, is definitely considering only the manufacturing process of that product, that is considering the operational level only, leaving out the context within which that product will operate. Although information systems quality cannot be separated from software process quality; they should be regarded as two different entities. It can be argued that information systems (IS) are the aim, whereas software serves for that aim, so that IS tend to be the organizational context where the developed software is used. IS therefore are built upon software, and the quality of software and software processes effect, if not determine the quality of the IS.

Unlike IS, the software quality assessment is mature and there are well established software development process assessment methodologies. ISO 15504 (Software Process Improvement and Capability determination) (1998) and CMMs (Capability Maturity Models) (Paulk, Curtis, Chrissis and Weber, 1993) are the two process based assessment methodologies which have originated from organisational theory. ISO 15504, being an international standard, is general in its normative components to encompass a number of process improvement approaches, including, but not limited to CMM-based improvement. CMMs in general, are guidance and reference documents. Therefore they provide more informative material for users at a lower level of detail, attempting to provide a vision for what an improved organization's practices would look like (Garcia, 1999).

In addition to above mentioned software focused methodologies, there are information technology focused disciplines such as Control Objectives for Information and Related Technology (CobiT), and

the Information Technology Infrastructure Library (ITIL) (2005). ITIL describes the service management processes and recommends security and control practices but does not have a standard for them which is where CobiT comes in because it provides a framework to perform audits on a particular organisation's ITIL processes. So rather than compete, CobiT and ITIL complement each other. Depending on the type of the organisation, one framework on its own may not be sufficient, and therefore two or more frameworks may be applied together in a complementary fashion (Özkan and Bilgen, 2005).

2 MATERIAL AND METHOD

We have conducted surveys at three organizations in Ankara region, Turkey. The survey is based on PB-ISAM. PB-ISAM is a process based assessment method for information systems effectiveness assessment. PB-ISAM consisted of 92 evaluation questions in 10 processes (Özkan, 2006).

PB-ISAM

This study is based on and supports the idea that information systems success must be visualized in a multi-dimensional manner in order to develop a framework for IS evaluation. Related literature has been reviewed focusing on evaluation techniques, paradigms, quality assessment disciplines in a comparative manner. Individual assessment frameworks examined yield convenient solutions in practice within their specific contexts. In conformance with the regard for the complementary nature of the fundamental frameworks in the literature (Özkan, 2006; Özkan, 2005); PB-ISAM (Process Based Information Systems Assessment Model) has been proposed and tested (Özkan, 2006). PB-ISAM is based on a conceptual model IS effectiveness as illustrated in Figure 1.

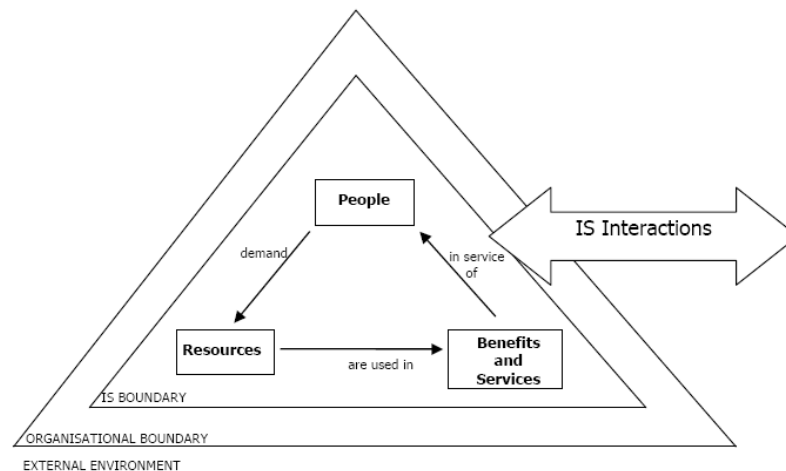


Figure 1 Conceptual Model of IS to be used for Effectiveness Assessment

PB-ISAM is comprised of (1) maturity level descriptions, (2) process objectives and (3) assessment metrics for the ten processes to be considered in assessing the components of the conceptual model and these are presented in detail in Özkan (2006). Table 1 shows the 10 processes of the method.

Table 1 Model components and corresponding assessment processes

Component of the conceptual model	Assessed with the processes
People	P1 Definition of the IS organisation and relationships P2 Education and training of users P3 Provision of assistance and advice to IS users
Resources	P4 IS interactions P5 Configuration management P6 Performance and capacity management P7 Operations management
Services and benefits	P8 Continuous Service P9 Change management P10 Monitoring services

These proposals do not constitute a *definitive* framework for assessment but rather they constitute a starting point for the framework to be established for each individual case. These proposals have been evaluated via three case studies. Each of the ten processes that have been described in detail in Ozkan (2006) shall be assessed according to the scale of five maturity levels:

- Level 0 Non-existent
- Level 1 Initial/ Ad hoc
- Level 2 Repeatable but intuitive
- Level 3 Defined process
- Level 4 Managed and measurable
- Level 5 Optimized

The 92 evaluation questions for all ten processes of PB-ISAM are presented in detail in Ozkan (2006).

3 CASE STUDIES FROM THE HEALTH SECTOR

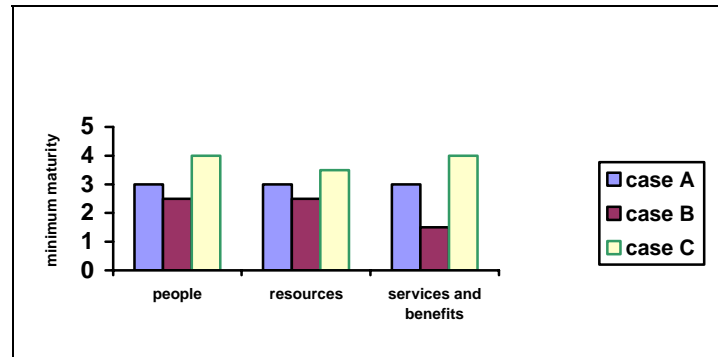
Application of PB-ISAM has been investigated in the IT departments of three health organizations. One of these, denoted as Case A, is the IT department of a large public university hospital; another, Case B, is of a public specialisation hospital; and the third one, Case C, is a private hospital. These three cases are meant to be demonstrative rather than exhaustive. In other words the cases show how the proposed effectiveness model and the assessment method can be used to guide both practical and empirical studies.

In the light of the three case studies, it has been observed that for the IT department of an organisation in the medical sector, the proposal for specifying the three major components as (1) people, (2) resources, and (3) services and benefits seems to be justified within the context of these three cases. The proposed conceptual approach extends previous work on information systems success evaluation by focusing on the processes related with these three major components. All three components were found to be equally important for the cases studied. In addition, this argument is found to be valid independent from the organisation. This independence has been verified by the three cases studied. One of the reasons for this independence is that these three components were initially derived from the working definition of IS evaluation. The minimum of the maturity levels for each of the three components of PB-ISAM for cases A, B and C are presented in Figure 2.

Aggregation of the assessment of individual processes, however, is beyond the scope of the current study, and could be considered after extensive experience is gained within the proposed assessment

method. The processes of the proposed model PB-ISAM were found to be relevant to the cases studied in the medical sector.

Figure 2 The minimum maturity of three components of PB-ISAM for cases A, B and C.



4 CONCLUSION

In this study, a novel model and an associated process based method of IS effectiveness that have been previously proposed and tested; have been reused in a different context, i.e. the medical sector. Specific implications drawn concerning the relationships between processes and the information system assessed (Özkan, 2006) are found to be context dependent. The conceptual model used in this study extends previous work on IS success evaluation by focusing on the processes related with three major components that construct an information system: people, resources, services and benefits. A number of lessons learnt about IS effectiveness evaluation will be valuable to any stakeholders and researchers involved in such assessment.

For the community of managers, the realisation that high quality information technology support being an integral factor in the success of today's public health professional has been invoked. IS developers and decision makers who often face IS effectiveness evaluation, a number of practical contributions are offered. In general, they would benefit from the research deliverables through a deep understanding of the processes related with IS effectiveness.

Indications of the practical contributions of the proposed approach have been verified by the initial feedback received from the case study participants. Some of the research findings (i.e. the maturity descriptions) have been used in Case C for the hospital's future information technology management and also for their self improvement. For the Case A, the research findings were perceived as an objective external assessment complementary to their organisation-wide evaluation efforts. In the last case, this study has been found to be beneficial to their overall improvement plans.

5 LIMITATIONS AND FURTHER RESEARCH

This study has focused particularly on the effectiveness of three components via processes identified. Roles and responsibilities of the individuals with whom the interviews have been conducted are inherently intangible, and their observed elements and the information they provide may have been influenced by other factors (e.g. 'local' politics, organizational privacy) for which the researcher was unaware. This might have affected the objectivity.

The conceptual model has been developed based on the discussion carried out in regard to model (1) objectives, (2) relations and (3) components; which has drawn the boundary of the research. The components of the conceptual model identified separately for analytical purposes, are highly interlinked and in some cases overlapped in real life situations. Their study in isolation might question

the credibility of the findings. It was then important not to attempt to fit the data to a generalised framework, but seek to interpret the findings as encountered in the empirical research. This was facilitated by the assessment framework adopted.

The research adopts the case study methodology, which has also experienced critiques. Benbasat *et al.* (1987) focus on the non-representativeness and the credibility of the results, in terms of generalisability. The limited number (three) of case studies limited the general validity of the conclusions. However, this study should be perceived as a complementary work to Özkan (2006), where the model and method application was accomplished within different contexts. This study, therefore complements previous work by showing the adoptability of an IS evaluation methodology within a specific context, i.e. the medical sector.

For future work, a new assessment method associated with the conceptual model proposed in this study might be studied. In that, other research methodologies could be utilised, for example a positivistic quantitative research methodology where the correlations of the model components might be examined on similar case organisations; and the results could be compared with the findings of this research.

References

- Adelakun, O., (1991) *Planning and Managing Strategic Information Systems Project: A Case study on IS quality process in ABC*, Turku Centre for Computer Science TUCS, and Turku School of Economics and Business Administration, Institute of Information Systems Science
- Andersson, T., Von Hellens, L., (1997) *Information systems work quality*, Information and Software Technology 39, pp. 837-844.
- Cameron, K. S., Whetton, D. A. (1983) "Some Conclusions about Organizational Effectiveness," in K. S. Cameron and D. A. Whetton (eds.), *Organizational Effectiveness: A Comparison of Multiple Models*, Academic Press, New York, 1983, pp. 261-277.
- Chang, J. C., King, W. R. (2005) Measuring the Performance of Information Systems: A Functional Scorecard *Journal of Management Information Systems*, Vol.22, No.1, pp.85-115
- Crowston, K., Treacy, M. E. (1986). Assessing the Impact of Information Technology on Enterprise Level Performance. Paper presented at *the Seventh International Conference on Information Systems (ICIS)*, San Diego, CA.
- Dahlberg, T., Jarvinen, J., (1997) *Challenges to IS quality*, Information and Software Technology 39, pp. 809-818.
- DeLone, W. H., McLean, E. R. (1992) Information systems success: The quest for the dependent variable. *Information Systems Research*, 3(1), 60-95.
- DeLone, W. H., McLean, E. R. (2003) The DeLone and McLean Model of Information systems success: A Ten-Year Update *Journal of Information Systems*, Spring, Vol.19, pp.9-30
- DeLone, W. H., McLean, E. R. (2004) Measuring e-Commerce Success: Applying the DeLone and McLean Information Systems Success Model *International Journal of Electronic Commerce*, Vol.9, No.1, pp.31-47
- Dickson, G. W., Wells, C. E., Wilkes, R. B. (1988) *Toward a derived set of measures for assessing IS organizations*. In N. Bjorn-Anderson & G. B. Davis (Eds.)
- Drucker, P. F. (1989) *The New Realities* New York: Harper & Row.
- Earl, M. J. (1989) *Management strategies for information technology* Prentice Hall.
- Eccles, R. G. (1991) The Performance Measurement Manifesto, *Harvard Business Review*, Vol.69, No.1, pp.131-137.
- Eriksson, I., Törn, A., (1991) A model for IS quality, *Software Engineering Journal*, pp. 152-158, August.
- Garcia, S. M. (1999) *Evolving Improvement Paradigms: Capability Maturity Models and ISO/IEC 15504 (PDTR) SEI*, Carnegie Mellon University, Pittsburgh, PA 15213
- Garvin, D., (1987) *Competing on the eight dimensions of quality*, Harvard Business Review, Nov-Dec, pp. 101-109
- Hopstaken, B. B. A., Kranendonk, A. (1988) *Informatieplanning in tweevoud*, PhD thesis, Universiteit van Leiden, Leiden, The Netherlands.
- ISO/IEC TR 15504 (1998) Information Technology, Software Process Assessment, Part 2: A reference model for processes and process capability.
- ITGI IT Governance Portal (2005) Available online at: www.itgovernanceinstitute.org
- ITIL Information Technology Infrastructure Library College (2005) Available online at: www.ITILcollege.com
- Kallinikos, J. (2004) Deconstructing information packages: Organisational and behavioural implications of ERP systems, *Information Technology and People*, Vol.17, No.1, pp.8-30
- Mason, R. O. (1978) Measuring information output: A communication system's approach. *Information & Management*, 1(5), 219-234
- Myers, M. D. (1997) "Qualitative Research in Information Systems," *MIS Quarterly* (21:2), June 1997, pp. 241-242. *MISQ Discovery*, archival version, June 1997, http://www.misq.org/discovery/MISQD_isworld/. *MISQ Discovery*, updated version, last modified: July 26, 2005 <http://www.qual.auckland.ac.nz/>

- Niederman, F., Brancheau, J. C., Wetherbe, J. C. (1991) Information systems management issues for the 1990s, *MIS Quarterly*, Vol.15, No.4, pp.474-500.
- Nolan, R. L., Mc Farlan, F. W. (2005) "IT and the Board of directors" *Harvard Business Review*, pp.96-106, October
- Özkan, S. (2006) *PB-ISAM: A new framework for the assessment of information systems effectiveness*, PhD Thesis, Department of Information Systems, Informatics Institute, Middle East Technical University, Available online at: <http://www.ii.metu.edu.tr/~sozkan/PhDthesis.pdf>
- Özkan, S., Bilgen, S. (2005) *Merging Information Technology Process Quality Frameworks with other Business Process Measurement Frameworks* in proceedings of the 12th European Conference on Information Technology Evaluation, ECITE 2005.
- Özkan, S. (2005) All Together Now: Merging Information Technology Quality and Other Business Performance Management frameworks *Cutter IT Journal The Journal of Information Technology Management*, Vol.18, No.3, pp. 16-20 March ISSN: 1522- 7383
- Özkan, S. (2004) Information Systems Quality versus Software Quality: A Process Based Assessment Model within the context of Organisation in proceedings of the 9th Association of Information Management Conference, AIM2004.
- Özkan, S., Bilgen, S. (2003) *Notes Towards IS Assessment: A Comparison of two Models within the Context of the Internet* in proceedings of the IADIS International Conference WWW/Internet 2003, Vol.2, pp.1215-1219.
- Paulk, M. C., Curtis, B., Chrissis, M. B., Weber, C. V. (1993) *Capability Maturity Model for Software, Version 1.1*, Technical Report, CMU/SEI-93-TR-024, ESC-TR- 93-177.
- Seddon, P. B. et al. (1999) Dimensions of Information Systems Success, *Communications of the Association for Information Systems*, Vol.2, No:20, November 1999
- Seddon, P. B., et al. (2002) Measuring Organizational IS Effectiveness: An Overview and Update of Senior Management Perspectives, *The DATA BASE for Advances in Information Systems*, Spring 2002, Vol. 33, No. 2
- Serafeimidis, V. (1997) *Interpreting the Evaluation of Information Systems Investments: Conceptual and Operational Explorations*, Ph.D. thesis, Department of Information Systems, London School of Economics and Political Science, University of London.
- Shannon, C. E., Weaver, W. (1949) *The Mathematical Theory of Communication* Urbana, IL: University of Illinois Press
- Symons, V. J. (1990) *Evaluation of Information Systems: Multiple Perspectives*. PhD Thesis, University of Cambridge.
- Vidgen, R. T., Wood-Harper, A. T. & Wood, J. R. G. (1993) A Soft System Approach to Information Systems Quality, *Scandinavian Journal of Information Systems*, Vol. 5, pp. 97-112.