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ABSTRACT

Valuation of information systems (IS) and information technology (IT) has gained a lot of attention over the years resulting in a broad range of approaches. We examine the use of valuation methods in a case study of a large public organization. Life cycle analysis was used to position and relate valuation methods. We found that eight different methods were used and that there was limited coordination among these methods. We argue that there is a need for more coherence among the use of methods in which the input and results of one method can be used by other methods. To obtain more coherence we recommend for the short term to select and use methods for valuation as an integrated set, and for the long term we plea for architecture-based valuation, to connect the decision-making process on value of IS/IT to the organization's enterprise architecture.

Keywords

Valuation, information systems, information technology, life cycle, enterprise architecture.

INTRODUCTION

Valuation of information systems (IS) and information technology (IT) is an area which has gained considerable interest in research and practice (e.g. Willcocks and Lester, 1999; van Grembergen and van Bruggen, 1998; Hirschheim and Smithson, 1999; Renkema and Berghout, 1996; Ranti, 2006; Remenyi et al., 2007; Mahmood and Szewczak, 1999; Devraj and Kohli, 2002; Lin, 2002). Valuation aims at assessing the contribution of IS/IT in quantitative and / or in qualitative terms. These assessments are often used as input for IS/IT decision-making during various moments of the life cycle and at strategic, tactical and operational levels. Various definitions of IS/IT valuation can be found in literature, see (Willcocks and Lester, 1996; Serafimidis and Smithson, 2000; Lin, 2002). For this research, a process-based definition of valuation is adapted:

“A process or group of parallel processes, which take place at different points in time or continuously for searching and for making explicit, quantitatively or qualitatively, all the impacts of an IT project and the program and strategy of which it is a part.” (Farbey et al., 1999).

By using a process-based definition we are able to look at valuation methods during the life cycle of IS/IT. Here we view IS/IT valuation as a *process of assessing the value of information systems and information technology of single or multiple organizations*.

Difficulties in measuring benefits and costs are often caused by uncertainty about expected benefits and hence are a major constraint to IS/IT investments. Often, the businesses require benefits and costs to be expressed in financial terms. In order to account for less tangible benefits and costs, intangible benefits and costs need to be included. The variety of valuation needs has resulted in a large number of valuation approaches and methods (Renkema and Berghout, 1996). Yet, there is little known about the actual use of this variety of methods in practice. This paper addresses this gap by investigating the valuation methods used by a large public organization and the relationship among these methods.

This paper is structured as follows. An overview of IS/IT valuation literature is presented as the theoretical background to analyze the case study. The research approach for the case study is described. In the case study the valuation methods used by a large organization are given and compared to expectations based on theory. This is followed by a discussion of the findings in practice. Finally, we draw conclusions and give recommendations for further research.

IS/IT VALUATION METHODS LITERATURE

The literature reveals a multitude of IS/IT valuation methods, each with its own characteristics and focus (e.g. Willcocks and Lester, 1999, van Grembergen and van Bruggen, 1998). The methods have a variety of characteristics which determine their potential use in organizations. Therefore an overview of relevant methods was made, based on the number of occurrences in the IS/IT valuation research literature. This served to indicate whether the method was considered important. To determine whether a method was commonly referred to in literature, we examined seventy publications. The methods thus selected were Cost Benefit Analysis, CBA (King and Schremms, 1978), Information Economics, IE (Parker, Benson and Trainor, 1988), Multi-Objective Multi-Criteria, MOMC (Kamal, 2001; Keeney and Raffia, 1993; Duarte and Reis, 2006), Return on Management, RoM (Strassmann, 1990), Real Options Theory, ROT (Benaroch and Kauffman, 1999; Li and Johnson, 2002), Balanced Scorecard, BSC (Kaplan and Norton, 1992), Portfolio Methods (Bedell, 1985), Value Networks (Allee, 2002), and Benchmarking (Hagge and Kreutzkamp, 2003). Refer to these publications for descriptions of methods.

Several factors can be used to show the differences between methods and determine their potential use and applicability. Table 1 plots the methods and compares them based on eight factors, we found by intersubjective judgment more or less implicit in literature. These factors allow us to characterize methods. The factors can be used by organizations to select valuation methods, appropriate for the organization, or to validate the existing valuation practice in the organization. This set of factors is not exhaustive. Further research may reveal more factors.

Factor Method	Qua(ant/l)itative	Profit/non-profit	Actors	Projects	Non-financial Consequences	Evolution	Cross-dependency	IS/IT Life cycle
Cost Benefit Analysis (CBA)	Combined	Both	Single	Single	No	Yes	No	Depends on use
Information Economics (IE)	Combined	Both	Single	Single	Yes	Yes	Yes	No
Multi-Objective Multi-Criteria (MOMC)	Depends on use	Both	Single	Single or multiple	No	No	No	No
Return on Management (RoM)	Quantitative	Profit	Single	Multiple	No	No	No	No
Real Options Theory (ROT)	Quantitative	Both	Single	Multiple	Yes	Yes	No	No
Balanced Scorecard (BSC)	Qualitative	Both	Single	Not applicable	No	Yes	No	No
Portfolio Methods	Depends on use	Depends on use	Single	Multiple	Yes	Yes	No	No
Value Networks (VN)	Quantitative	Both	Multiple	Not applicable	Yes	Yes	No	No
Benchmarking	Quantitative	Both	Multiple	Multiple	No	Yes	No	No

Table 1. IS/IT valuation methods overview of eight distinctive factors for applicability

Qua(ant/l)itative

This factor indicates whether a method is quantitative, qualitative, or both. Quantitative methods are often grounded in financial and economic theories. Qualitative methods incorporate significant consideration for strategic elements and variables, which are difficult to quantify. The intangible nature of certain IS/IT costs and benefits causes difficulties in quantifying. Most IS/IT approaches are quantitative.

Profit/non-profit

This factor indicates the applicability of a particular method for profit and/or non-profit organizations. Generally, existing methods do not distinguish between the categories, although some, like ITGI’s Value of IT (ITGI, 2006), which is a combination of CBA and Portfolio Methods in Table 1, and RoM are clearly written for the profit sector.

Actors

This factor indicates whether a method applies to a single actor or multiple actors. Most methods apply to a single actor. Value Networks and Benchmarking consider multiple actors. Value Networks focus on the exchange of values between actors in network situations. Benchmarking compares values across actors, mostly for cost comparisons.

Projects

This factor indicates whether a method is able to value a single project or multiple projects within an organization. Valuation of a single project is often done for go-no go decisions, and for tracing costs and benefits. Valuation of multiple projects is often done for selecting which projects will be funded. It is relevant to know whether a method considers all components of IS/IT (including hardware, software, data, people, processes and environment). Most of the methods value specific projects and all take the different components into account. The traditional financial approaches cover single IS/IT projects only. RoM looks at the consequences of investing in IT at the level of the entire organization. MOMC and Portfolio Methods consider multiple projects in the valuation.

Non-financial Consequences

This factor addresses the aspects of risks and consequences that are considered by the IS/IT valuation. Almost all methods look at financial consequences. The different methods take a variety of non-financial consequences into account. Almost all methods address business and technological concerns. In contrast, organizational and social concerns are ignored by most methods. In IE risks are considered as negative consequences and are deducted from the benefits. RoM and the Bedell Portfolio Method do not include risk. Risk is considered by some valuation methods. However, there is an absence of valuation methods for measuring the associated risks involved in planning and implementing IS/IT (Gunasekaran et al., 2006).

Evolution

Support and ability to evolve refer to the extent to which a method indicates or prescribes how it should be used in valuation practice, and to the extent it considers the future revisions of IS/IT. Some methods, like MOMC and RoM, do not describe the process of making the possible benefits more tangible, nor consider the future revisions.

Cross-dependency

This factor addresses the interrelationships among existing systems under valuation and analyses the impact of the systems and processes that are depending on the system under valuation. This may include systems from other organizations. Most existing methods do not address interdependencies. Only IE does this to some extent. Operational dependencies, goal dependencies, contractual and portfolio dependencies, change, risk and compliance dependencies are not covered by most methods.

IS/IT life cycle

The costs of IS/IT commonly include the costs of developing and maintaining the system. The valuation method is expected to cover the costs, benefits, and risks involved in the system's entire life cycle, including phasing out. Table 1 shows that most of the existing methods do not focus on the life cycle of IS/IT in the investment decision making process.

RESEARCH APPROACH

To better understand the various valuation methods in practice an explorative case study was conducted in a large public organization. We opted for a case study as this enabled us to understand the rationale for selecting the valuation method, the use and relationship with other valuation methods in detail (Yin, 2003). The case study was conducted during the second half of 2009. Document analyses and interviews were used. The interviews were semi-structured using the following elements:

- current valuation practice
- relationship with other valuation methods
- position in the IS/IT life cycle
- suggestions for improvement.

In total seven interviews were conducted with functions and teams in the organization working in valuation. This included project managers, portfolio management team, function point analysis and quantitative software management team, IT

architect, enterprise architect, business case specialist and an external expert in examining the impact of new laws, or changes in laws on society.

Most interviews were done by two researchers. All interviews were transcribed. The transcripts were provided to the interviewees within a short time frame and the interviewees were asked to validate and approve the transcripts. Several comments were received, and the updated final transcripts were sent to the interviewees. Based on interview transcripts a case study report was developed. The case study report was distributed and discussed with the interviewees and other staff to gain feedback and verify the correct understanding. The mapping of the valuation methods on the IS/IT life cycle, see Figure 1, was validated by presenting it during a workshop in January 2010.

CASE STUDY: A LARGE PUBLIC ORGANIZATION

The organization under investigation has more than 30,000 employees. It operates a large computer center for governmental purposes. The organization invests heavily in IS/IT with a budget of more than four hundred million Euro on a yearly basis. The organizational profile is given in Table 2 using the factors discussed in the background section.

Factor Profile of:	Qua(ant/l)itative	Profit/ non-profit	Actors	Projects	Non-financial Consequences	Evolution	Cross-dependency	IS/IT Life cycle
Large public organization	Combined	Non-profit	Single and multiple	Single and multiple	Yes	Yes	Yes	Yes

Table 2. Profile of valuation requirements of the large public organization in the case study

The organization has a need for both quantitative and qualitative valuation methods, in the non-profit sector, for situations having single or multiple actors and projects, including non-financial consequences, allowing for evolution, supporting cross-dependency, and usable along the entire IS/IT life cycle. When this profile is compared with the list of existing methods in Table 1, it becomes clear that no single method can fulfill all these requirements. Methods that scored best for this organization are CBA, IE and Portfolio Methods. For multiple actors and projects the Benchmarking method scored best for this organization. In short, based on the confrontation of the organization characteristics and theoretical methods, we expected to find CBA, IE, Portfolio Methods and Benchmarking as the main methods in use by the large, public organization.

The interviews and document analyzes showed that this organization uses eight different IS/IT valuation methods at different locations in the organization. The valuation methods were used for both financial and quality purposes. The main methods and their use can be summarized as follows:

- Societal Cost-Benefit Analyses (CBA) - When new or modified legislation is proposed at the political level, the global costs and benefits for society are estimated. This valuation is at a macro-level and often done by an external research institute;
- Balanced Score Card (BSC) - The BSC is used by controllers to control projects at the strategic level;
- Cost-Benefit Analysis (CBA) - This type of analysis is used by project managers to make the business case for new investments in technology and obtain budget approval;
- Portfolio Methods: Project Portfolio Management (PPM) - The portfolio is used by portfolio management teams and business people to evaluate projects in order to prioritize them in their importance and to allocate scarce resources and budgets;
- Portfolio Methods: Application Lifetime Measurement Method (ALMM) - A procedure from the Application Services Library (Bos, Mooten and Dorp, 2005) is used by IT architects to measure business value and technical value for Application Portfolio Management (APM). APM is focused on decisions concerning maintenance of existing applications, whereas PPM is focused on projects for new or existing IS/IT developments;
- Portfolio Methods: Source Code Analysis (SCA) - A method of the Software Improvement Group for improving the quality of the application portfolio, and for APM, i.e. decisions between phasing out or investing in applications (www.sig.nl);

- Function Point Analysis (FPA) - A method to estimate the required effort for software development or for IS development productivity measurements (Garmus and Herron, 2000). It is used by a specialized team and primarily focused on estimation of the programming efforts required;
- Benchmarking - Methods for comparing costs for selected topics with the costs of similar organizations to find areas for cost reduction. Benchmarking is done by external parties using databases.

When we compare the valuation methods found in practice to the expected methods, based on the characteristics in Table 2, then CBA, Portfolio Methods and Benchmarking were expected and were actually found. BSC was not expected, but was found. IE was expected, but was not found. These differences provide input for validating the valuation practice. For instance the question should be answered how the organization is going to address cross-dependencies between IS/IT systems, since IE was the only method in Table 1 to address cross-dependencies.

The valuation methods are used at various levels of detail, ranging from societal, organization, department to project level valuation. Figure 1 shows the position of the valuation methods mapped on the IS/IT life cycle. The life cycle is based on the policy-making cycle, starting with policy analyses and ending with policy implementation. Since the organization is working with projects, we have translated the life cycle of IS/IT as starting with a law proposal, preparation, project definition, execution and closure, and ending with portfolio management including phasing out IS/IT.

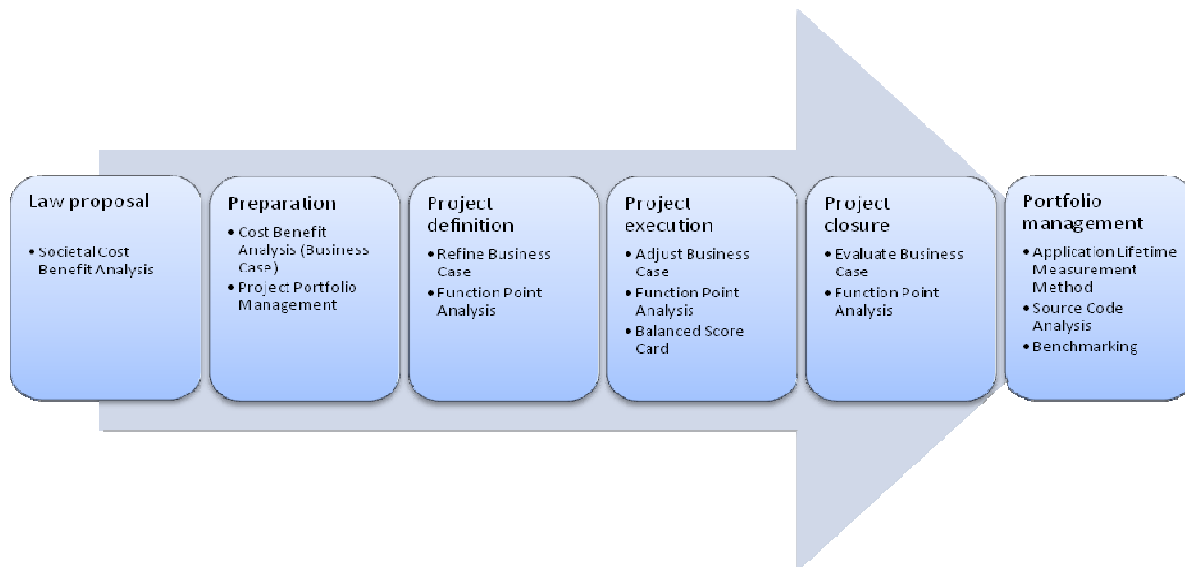


Figure 1. Valuation methods projected on the life cycle of IS/IT

Often methods based on experience or advocated by practitioners were used. No deliberate decision-making process to select appropriate methods was found. Methods were used in a fragmented way and not consistently applied. Reasons for this are resource constraints, and lack of knowledge and control on the use of methods. For instance:

- Not all projects had business cases. Business cases were made selectively, only for expensive investments above a certain investment level. Making a business case is costly.
- There was an Application Lifetime Measurement Method for APM, but there was no Infrastructure Lifetime Measurement Method. Thus, life cycles of IS systems were taken into account, but life cycles of IT systems were not. This can be explained by the distributed responsibilities of application and infrastructure by two departments. Both use different organizational procedures and standards.
- Benchmarking was only done in specific areas for cost reasons. Other areas were left out, or done in the next round.

The fragmentation and the size of the organization resulted in that users of the methods were sometimes unaware of valuation efforts in other parts of the organization, and thus did not reuse each other’s data. This was confirmed by our research, as we were not able to find all methods in a single place.

Some methods were used consecutively to other methods. For instance FPA was used as input for CBA in business cases and PPM. The entire set of valuation methods was not interrelated. ALMM, SCA and Benchmarking could be used as input for

portfolio management, since all are positioned after project closure in Figure 1. The mapping of the valuation methods on the IS/IT life cycle, see Figure 1, came as a surprise to most stakeholders and proved to be valuable to relate the practices.

Some methods, like CBA and PPM, which could be used along the entire IS/IT life cycle, were mainly used for go or no-go decisions, at the beginning of the life cycle. Whereas potentially they could be used during project execution or after project closure, this was not done. An explanation for this is time pressure, a lack of knowledgeable resources to accomplish this, and the fact that PPM was relatively new in this organization.

Although the organization has established an enterprise architecture to provide Business-IT Alignment and guidance to IS/IT developments, architects were not involved in valuation other than providing input for business cases, lists of projects for PPM, or measurements for business and technical values for APM.

DISCUSSION

Rationalization of IS/IT valuation

The organization uses several methods for IS/IT valuation. This indicates that some methods, like the CBA in the business case, are not used to their full extent across the IS/IT life cycle. If these methods were used throughout the IS/IT life cycle, instead of only for making a go or no-go decision for the initial investment, it might make other methods superfluous. We expect that once relevant methods are used along the entire life cycle, less methods will be necessary for IS/IT valuation.

Further integration between methods is considered appropriate. FPA results are used as input to CBA in the business case, but results of ALMM, SCA and Benchmarking were not used in Portfolio Management. Their results could be used as input for a more integrated way of portfolio management, especially since they are positioned after project closure when the organization is managing the portfolio of existing IS/IT.

There was an Application Lifetime Measurement Method, but there was no Infrastructure Lifetime Measurement Method. To take life cycles of IT systems into account for Infrastructure Portfolio Management, a method for Infrastructure Lifetime Measurement could be developed or selected.

Interrelationship of components in IS/IT valuation

Interestingly, we can see both from the theory and from the practice sections, that the methods used for IS/IT valuation do not focus on the interrelationships among IT components, or their reuse in different situations. Only IE does this to some extent, see Table 1, but IE was not used by the case study organization. Most methods look at IS/IT as if point solutions are concerned. This is striking given that present day IS/IT landscapes are extensively interconnected. One cause is that many of the valuation methods are based on different starting points and different inputs. The use of another method often requires collection of additional data and making new assumptions. Furthermore, different decision-makers are involved ranging from politicians to project managers to line managers to architecture and portfolio boards.

IS/IT valuation: a multi actor process using multiple methods

The results indicate that there is no single method that is able to serve all purposes for all types of decisions. This suggests that no single actor within organizations should monopolize IS/IT valuation, nor should IS/IT be seen as a uniform entity. This aspect needs further research.

Having knowledge of a diversity of valuation methods by the organization proved to be problematic. By educating staff from various departments, collaboration among departments can be stimulated. This might help to understand each other's activities and needs. People in different departments using different valuation methods should be made aware of and educated on the entire set of methods used for IS/IT valuation within the organization.

Architecture-based valuation

The methods in the theory section do not use architecture, but stem from disciplines such as economy, quality management, management and organization. By basing valuation on architecture, we believe that decision making on IS/IT can be improved. Furthermore, the effectiveness of architecture itself increases when architects and managers are able to value based on architecture. Away with great architectures that do not get realized since their value remains unclear to management. We plea for architecture-based valuation. First instances of architecture-based valuation were created in the ArchiValue project (www.novay.nl), see (Lankhorst, Quartel and Steen, 2010).

In enterprise architecture (EA) frameworks, the design cycle is leading, instead of the decision-making cycle as in many IS/IT valuation methods. For instance, The Open Group Architecture Framework (The Open Group, 2009) uses a design cycle consisting of several phases. Yet this design cycle is not used for matching or positioning valuation methods. EA models might form a basis for more coherent valuation in several ways, for instance:

- EA shows which business goals, processes, and other systems use a given system. This is crucial valuation information since the cost of a system may be easily associated with the system itself. The value on the other hand is often in its use and its compliance with business goals.
- Cross dependencies are important risk factors. Architectures depict cross dependencies in IS/IT, and thus can form the basis for risk assessment and calculations to deduct from the benefits and obtain a more realistic view of IS/IT developments.
- EA uses repositories for IS/IT building blocks. Values of building blocks can be associated to these blocks in the repository providing more coherence in valuation across the life cycle. In that way values of building blocks can be adjusted and reused during the life cycle. People using methods do not need to start all over again to find what the values are of IS/IT building blocks.
- Valuation based on EA may further connect the decision processes of IS/IT valuation with the design processes of enterprise architects. This may contribute to the value of EA.

We will explore this direction of research in more detail in our future work, including the possibility to perform architecture-based valuation throughout the IS/IT life cycle, and including learning from valuation in other sectors on using divergent approaches. Our aim is to connect IS/IT valuation with EA.

CONCLUSION

There is a plethora of IS/IT valuation methodologies available, however, there is limited insight in their actual use. Commonly used methods were characterized based on eight factors which helped to determine the appropriateness in certain situations. These factors are Qualitative, Profit/non-profit, Actors, Projects, Non-financial Consequences, Evolution, Cross-dependency and IS/IT life cycle. These distinctive factors can be used to select methods and to validate valuation practice.

A case study of a large public organization was investigated to better understand the use of valuation methods in practice. The organization has requirements on valuation methods, which cannot be fulfilled by a single method found in literature. The study revealed that a variety of methods were used for different type of decisions at different positions in the organization and at different points in time. The comparison of the valuation methods found in practice to the expected methods, showed that CBA, Portfolio Methods and Benchmarking were expected and were found. BSC was not expected, but was found. IE was expected, but was not found. This raised the question how the organization is handling cross-dependencies in valuation of IS/IT, since IE was the only method to cover cross-dependencies.

There was limited awareness among the interviewees of the use of other methods than their own within the large organization. Some methods were not the regular models found in literature, and some of them were advocated by organizations and practitioners. The valuation methods were used at various levels of detail. Mapping the valuation methods on the life cycle provided insight in the position and use for the organization. Apart from the rationalization of the number of methods, a potential improvement is to relate the valuation methods and reuse their data and input. For instance ALMM, SCA and Benchmarking could be used as input for portfolio management.

We recommend to select methods for valuation as an integrated set and identify the interfaces between methods used to obtain more coherence. Select and combine the methods used such that interrelationships are clear, that methods are complementary and used consistently throughout the IS/IT landscape and life cycle. This will help to align the methods with each other. A suggestion is to develop a repository of data and evaluation methods which can be used for various purposes. By having a repository, data, collected for one method, can be used for other methods. To give guidance to the use, new organizational procedures for using and selecting valuation methods can be introduced. This could start by having a guideline to look at previous related valuations and stating conditions explaining which method can potentially be used in which situation.

Future research can explore architecture-based valuation of IS/IT. An architecture-based valuation connecting decision-making processes on IS/IT to the design processes of enterprise architects could be developed. This requires a shift from

decision to design-orientation, or a bridge between decision and design. Thus more coherence in IS/IT valuation could be obtained than is currently possible.

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REFERENCES

1. Allee, V. (2002). A value network approach. Presented at Transparent Enterprise Conference, Madrid.
2. Bedell, E.F. (1985). *The computer solution: strategies for success in the information age*. Dow-Jones Irwin, Homewood.
3. Benaroch, M. and Kauffman, R.J. (1999). A Case for Using Real Options Pricing Analysis to Evaluate Information Technology Project Investments. *Information Systems Research*. 10 (1). 70-86.
4. Bos, M., H. Mooten and C. Van Dorp (2005) Applicatie Levensduur Meet Methode (Application Lifetime Measurement Method), retrieved from www.aslbisfoundation.org/component/option,com_docman/.../lang.nl on February 24, 2010.
5. Devraj, S. and Kohli, R. (2002). *The IT Payoff - Measuring the Business Value of Information Technology Investments*, Prentice Hall Publishers, Upper Saddle River.
6. Duarte, B. and Reis, A. (2006). Developing a projects evaluation system based on multiple attribute value theory. *Computers and Operations Research* 33.1488-1504.
7. Garmus, D. and Herron, D. (2000). *Function Point Analysis – Measurement Practices for Successful Software Projects*. Addison-Wesley, Pearson Education, Upper Saddle River.
8. Grembergen, W. van, and Bruggen, R. van. (1998). Measuring and improving corporate information technology through the balanced scorecard. *Electronic Journal of Information Systems Evaluation*, 1(1).
9. Farbey, B., Land, F., and Targett, D. (1999). Moving IS evaluation forward: learning themes and research issues. *Journal of Strategic Information Systems*. 8(2). 189-207.
10. Gunasekaran, A., Ngai, E.W.T., and McGaughey, R.E. (2006). Information Technology and Systems justification: A Review for Research and Applications. *European Journal of Operational Research*. 173. 957-983.
11. Hagge, L. and Kreutzkamp, J. (2003). A Benchmarking Method for Information Systems. In: *Proc. of the 11th IEEE International Requirements Engineering Conference*.
12. Hirschheim, R. and S. Smithson (1999): Evaluation of information systems, in L.P. Wilcocks and S. Lester (Eds.) *Beyond the IT productivity paradox*, 1999, Chichester, John Wiley and Sons, 381-403.
13. ITGI (2006): *Enterprise value: Governance of IT investments – The Val IT framework, The business case, The ING case study*, ITGI, Rolling Meadows.
14. Kamal, M. (2001). Application of the AHP in project management. *International Journal of Project Management*, 19, 19-27.
15. Kaplan, R. and Norton, D. (1992). The balanced scorecard - Measures that drive performance. *Harvard Business Review* (Jan-Feb): 71-79.
16. Keeney, R.L. and Raiffa, H. (1993). *Decisions with multiple objectives: preferences and value tradeoffs*, Cambridge University Press, Cambridge.
17. King, J.L., and Schrems, E.L. (1978). Cost Benefit Analysis in Information Systems Development and Operation. *ACM Computing Surveys (CSUR)*. 10(1). 19-34.
18. Lankhorst, M.M., Quartel, D.A.C. and M.W.A. Steen (2010). Architecture-Based IT Portfolio Valuation. In: *Proceedings of Practice-driven Research on Enterprise Transformations (PRET 2010)*. Delft, Springer Verlag, 78-106.
19. Li, X. and Johnson, J. (2002). Evaluate IT investment opportunities using real options theory. *Information Resource Management Journal*, 15(3), 32-47.
20. Lin, C. (2002). An investigation of the process of IS/IT investment evaluation and benefits realization in large Australian organizations. Ph.D. Thesis. Curtin University of Technology, Perth, Sydney.
21. Mahmood, M.A., and Szewczak, E.J. (Eds.) (1999). *Measuring IT Investment Payoff*. Idea Group Publishers, Hershey.

22. Parker, M. M., Benson, R. J. and Trainor, H. E. (1988). *Information Economics, Linking Business Performance to Information Technology*, Prentice-Hall, London.
23. Ranti, B. (2006). A Review of Information Technology Investment Evaluation Methodologies: The Need for Appropriate Evaluation Methods. In: *Proceedings of the National Conference on ICT*, Indonesia.
24. Remenyi, D., Money, A., and Bannister, F. (2007). *The Effective Measurement and Management of ICT Costs and Benefits*, CIMA Publishing, Riverport.
25. Renkema, T.J.W. and Berghout, E.W. (1996). Methodologies for information systems investment evaluation at the proposal stage: a comparative review. *Information and Software Technology* 39. 1-13.
26. Serafimidis, V. and Smithson, S. (2000). Information Systems Evaluation in Practice: A Case study of Organizational Change. *Journal of Information Technology*. Vol. 16. 93-105.
27. Strassmann, P.A. (1990). *The Business Value of Computers*, The Information Economics Press, New Canaan, CT.
28. The Open Group (2009). *TOGAF version 9*, Van Haren Publishing, Zaltbommel.
29. Willcocks, L.P. and Lester, S. (Eds) (1999). *Beyond the IT Productivity Paradox*. Wiley Publishers, Chichester.
30. Yin, R.K. (2003). *Case study research - Design and methods*, Sage, Thousand Oaks.