Theme:

Title: **How to select an IT evaluation method – in the context of construction**

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Abstract: *In a number of surveys (both national and international) it has been highlighted that companies from the construction industry have difficulties with evaluating IT investments (Andresen 1999;CICA & CIRIA 1995). The reasons for this are many but one of the major ones is the poor adoption of IT evaluation methods. This paper focuses on how companies can choose between the many available IT evaluation methods by presenting a framework for how to choose a matching method. The primary objective of the paper is to present the findings of a completed Ph.D. project, but also importantly to discuss why this topic is relevant for companies in the construction industry by highlighting the benefits of increased knowledge of the value of companies' IT investments.*

The framework has been developed on the basis of both theoretical and empirical data collection and analysis of the available methods, a questionnaire survey and five case studies. Firstly, 82 IT evaluation methods have been identified in a literature review (and the list is not complete), from which a number of characteristics have been derived, and this has enabled a categorisation of the identified methods. Secondly, a national survey was completed investigating the sophistication of the Danish companies' IT evaluation practice. This was done in order to establish an overview of current IT evaluation practice. Thirdly, five case studies were completed in which four different methods were tested according to their usefulness in real-life IT evaluations.

The presented framework consists of (a) 21 parameters (which can be used to describe the characteristics of different IT evaluation scenarios), (b) a weighting system (allowing putting a higher emphasis on certain parameters) and (c) a set of procedures for identifying a matching IT evaluation method. The framework's output has been validated by comparing these with the experience gained in the case studies.

Keywords: *Evaluation, IT investments, Selection of method*

Introduction

Very often companies in the construction industry (this is valid in other industries as well) have little knowledge of how to evaluate both their future IT investments and their current IT systems and are, because of this, often completing an evaluation where IT investments are justified on the basis of subjective criteria such as personal preferences, competitors' activities etc. (Andresen 1999). A consequence of this is that very few companies actually have an in-depth knowledge of what value they achieve from their IT spending. This is obviously not good for a number of reasons. First, in times, when many types of investments (both IT and non-IT related) are in competition for the scarce resource of money, it is necessary to be able to evaluate and demonstrate the value of the company's IT spending. This will give the company a better foundation for prioritising between the available investments (it will also help the company with identifying the best IT investments). Second, identifying the value of a company's IT investments will highlight the costs and benefits they should strive to reach when implementing and using the IT systems. Knowing the targets (by using specific measures) of the company's IT usage enables the company to achieve a better control of IT spending and a better management of the IT investments. This is ideally resulting in resources being spent optimally and maximum benefits achieved. Third, IT evaluations are always completed either informally or formally, but IT evaluations completed informally are more easily biased towards political objectives and/or personal interests which might not be in the company's interest, whereas formal IT evaluations ensure

more objective, and often also a more thorough IT evaluation, as the criteria used are standardised and better defined. Completing a formal IT evaluation does, however, not necessarily ensure an objective evaluation as it is possible to augment the data used in the IT evaluation method so that it suits the desired purpose, but a formal IT evaluation may reduce the possibilities of adapting a process that is likely to provide a desired output.

To provide a solution to the above-mentioned problem is not easily done and requires several steps to be accomplished. One of the necessary steps is to enable a company to choose a matching IT evaluation method among the available methods that fulfil the requirements of the actual IT evaluation. This is the primary objective of the framework presented in this paper.

The availability of IT evaluation methods

Companies from the construction industry should not just increase their awareness of the availability of IT evaluation methods, but they should also be capable of selecting a method that fulfils the actual requirements of the IT evaluation. This is not an easy task as there are a considerable number of IT evaluation methods to choose between. Completing a literature search identified as many as 82 methods and there are,, without doubt, many more as new methods are being developed continuously. The list of methods is created primarily by combining the lists provided by (Farbey, Land, & Targett 1993;Powell 1999;Remenyi, Money, & Twite 1995;Renkema & Berghout 1997) and by adding methods identified in the literature search. However, not all the methods listed are specifically designed for evaluation of IT investments but may be used for that purpose as well and, lastly, several of the methods can be considered as combinations of other methods. The combined list of methods can be found in (Andresen 2001).

The identified methods can be described by a large number of characteristics ranging from, for example, those using very crude measures to very complex measures, being primarily ex-ante or ex-post in nature. A list has been derived from (Farbey, Land, & Targett 1993;Powell 1999;Renkema & Berghout 1997) and is outlined in the following.

- Type of IT investment
- Type of impact
- Evaluation criteria
- Stage of IT evaluation
- Type of outcome
- Difficulty of method
- Extent of involvement
- Cost of method
- Scope of method

A way of getting a better overview of the identified methods is to categorise the methods after one of their characteristics. One possibility is to categorise the methods after their predominant output, and that requires a definition of different types of output. Three groups of methods are therefore defined based on the possible types of output.

- **The financial methods**
  Methods, that have an output of a financial character or which are expressing a financial condition, are categorised in this group. They assess the IT investments' financial value by analysing its cash in- and out-flow and may assign arbitrary monetary values to non economically measurable costs and benefits.
- **The quantitative methods**
  The methods categorised in this group provide an output with one or several non-financial and quantitative measures when evaluating the IT investment. This implies that the evaluation is completed by using, not only a financial criterion, but also non-financial criteria. In the case of methods using multiple criteria, they may combine the measures into one single quantitative output, or each of the measures may be quantitatively expressed using one of the criteria.

- **The qualitative methods**
  The last group of methods is categorised as evaluating IT investments by providing qualitative output (e.g. portfolio diagrams and subjective statements) which, by definition, are not quantitative. The methods are not in themselves focused on providing a financial output even though this might be a part of the completion of the method.

Categorising the identified methods into one of the three groups of methods, as defined above, is shown in Table 1.

Table 1. The identified methods categorised after their predominant output

The Financial methods	The Quantitative methods	The Qualitative methods
• Accounting Rate of Return (ARR) • Application transfer team approach • Breakeven analysis • Boundary values (BV) • Business Impact or Time Release Analysis • Cost Avoidance • Cost Benefit Analysis (CBA) • Cost Benefit Ratio • Cost displacement • Cost effectiveness analysis • Cost-value technique • Cost-revenue analysis • Decision Analysis • Delphi evidence • Economic Assessment – I/O Analysis • Executive Planning for Data Processing (EPDP) • Hedonic wage model • Internal Rate of Return (IRR) • Lautanala's method • Net Present Value (NPV) • Payback period • Profitability index method (PIM) • Relative Competitive Performance • Return On Investment (ROI) • Return on Management (ROM) • Requirements-costing technique • SESAME • Structural models • Time savings times salary • Transformate Model • Zero based budgeting	• Analytic hierarchy process • Application benchmark technique • Automatic value points • Balanced scorecard • Bayesian analysis • Bradford Information System Evaluation Method (BISEM) • Information Economics (IE) • Information Systems Investment Strategies (ISIS) • A Health Check of the Strategic Exploitation of IT • Knowledge based systems for IS evaluation • Kobler Unit framework • Measuring the Benefits of IT Innovation (MBITI) • Multi Objective Multi Criteria (MOMC) • Option theory • Quality engineering • Satisfaction and priority survey • Strategic Investment Evaluation and Selection Tool Amsterdam (SIESTA) • Seven milestone approach • Strategic Match Analysis and Evaluation • Systems measurement • User Information Satisfaction (UIS) • User utility function assessment technique • Value Analysis (VA)	• Bedell's method • Benefits-risk portfolio • Benefit assessment grid • Buss's method • Composite and ad hoc methods • Critical Success Factors (CSF) • Customers resource life cycle • Functional Analysis of Office Requirements • Game-playing and role-playing • Investment mapping • Investment portfolio • Potential Problem Analysis (PPA) • Process Quality Management (PQM) • Proportion of Management Vision Achieved • Prototyping • Simulation • Socio-technical project selection • Strategic Application Search (SAS) • Strategic option generator • System dynamics methodology • Systems Investment Methodology (SIM) • Value Chain Assessment • User Attitudes • Ward's portfolio analysis • Work Study Assessment

The table contain 79 methods that are almost equally distributed across the three groups of methods. 3 of the identified methods could not be categorised because of the lack of literature describing them.

The development of the framework

In the pursuit of developing a framework that can be used as a tool by a company from the construction industry to select an IT evaluation method, a number of case studies were completed where a number of methods were tested according to their usefulness in evaluating an IT investment.

Four of the methods listed in Table 1 were identified, on the basis of a number of criteria, as being useful in the completion of the case studies. The selection criteria were, amongst other things, that they should be representative of a larger group of methods and that they should be well structured and useful in a construction industry context. The selected methods are the following (for further details about the methods see the (Andresen 2001)).

- Net Present Value (NPV) (Brealey & Myers 1988)

- Measuring the Benefits of IT Innovation (MBITI) (Construct IT 1998)
- Information Economics (IE) (Parker & Benson 1988)
- Critical Success Factors (CSF) (Rockart 1979)

All three groups of methods are represented in the selection of the four methods where the group of quantitative methods are represented by two methods. MBITI was selected as a second method of the group of quantitative methods primarily because it is developed especially for the construction industry (only two methods were developed for construction).

Five case studies were initiated on the basis of a number of criteria such as an actual need for completing an IT evaluation, and the investment should be relevant in the context of construction. The purpose of the case studies was gathering data within two primary areas.

- Identifying the parameters that influence the company's choice of method
- Examining the four methods' usefulness in different IT evaluations

The five case studies, two contractors and three consulting engineers (all Danish companies), were analysed in-depth with the purpose of identifying the characteristics of the IT evaluation useful for achieving the necessary understanding about the two areas above. Four of the case study companies are among the largest companies of their kind in Denmark, whereas the fifth was a local contractor. This was primarily because the range of case studies should represent different scenarios for IT evaluation.

All four methods were sought to be completed in all five case studies, but in one of the case studies only one method (CSF) was actually completed because of the case study company's resistance to spending resources on completing three of the methods.

The framework

The developed framework consists of three levels.

- The parameters that have been identified as influencing the choice of IT evaluation method
- A specification of different attributes representing different conditions of each parameter
- The relationship between the parameters' attributes and the usefulness of the four IT evaluation methods

The first level in the framework is the parameters that have an influence on the choice of method. These were primarily determined through the case studies, but some of them were also identified through a literature search and a questionnaire survey (Andresen 1999). The complete list of parameters is seen in Table 2.

Table 2. List of identified parameters

Company	IT evaluation	IT investment
o Company type o Company size o Company position o Business strategy o Decision environment o Role of IT o IT maturity o IT evaluation practice	o Purpose of IT evaluation o IT evaluation criteria o Format of output o IT evaluation champion(s) o User of IT evaluation o Cost of IT evaluation o Difficulty of IT evaluation method	o Type of IT investment o Size of IT investment o Purpose of IT investment o IT investment domain o Stage of IT investment o Importance of IT investment

In total 21 parameters were identified as influencing the choice of method. These were, after an analysis, grouped into three groups depending upon their natural relationship: Company, IT evaluation and IT investment. In combination the parameters represent a wide variety of characteristics of an IT evaluation.

The second level consists of a definition of a number of attributes for each parameter that represents the possible conditions the parameters can undertake. In the majority of the identified parameters only one attribute can be valid (as they are defined so they are mutually exclusive), but for two of the parameters several of the attributes can be valid. The complete list of the parameters' attributes is not included in this

paper, but as an example, Figure 1, shows the defined attributes in the parameter: Purpose of IT evaluation.

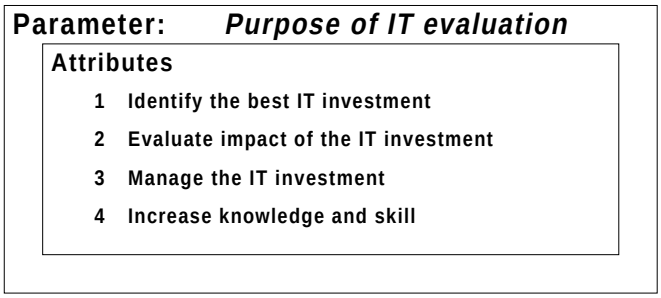

Figure 1. Attributes in Purpose of IT investment

The third level consists of a map showing the relationship between each of the parameters' attributes and the four methods tested in the case studies. A number of usability scores defines how well each of the four methods fulfils the requirement(s) derived from the parameters' attributes: *X*, *(X)* and *No Cross* respectively referring to: Useful, Usable and Not useful (a more precise definition can be found in (Andresen 2001)). Continuing the previous example the map between the parameter: Purpose of IT evaluation's attributes and the four methods is shown in Table 3.

Table 3. Relationship between Purpose of IT evaluation and the four IT evaluation methods

	NPV	MBITI	IE	CSF
Purpose of IT Evaluation				
Identify the best IT investment	X	(X)	X	(X)
Evaluate impact from IT investment	X	X	X	
Manage IT investment		X	(X)	X
Increase knowledge and skill	X	X	X	X

Implementing and using the framework

The framework has been implemented in two different versions allowing a user-friendly and efficient usage of the framework. The first version is paper-based and useful in achieving a detailed understanding of how the framework is structured, but it also requires a certain amount of tedious calculation that is time consuming. The second version, called SITEM (an abbreviation for Selecting an IT Evaluation Method), is developed in a software-based tool called Kappa V. 2.4, which is a developer's tool for creating expert systems. Only the software-based version of the framework is presented in further detail in this paper whereas more detailed information on the paper-based version can be found in (Andresen 2001).

A procedure showing four steps necessary when using the software-based framework is presented in Figure 2.

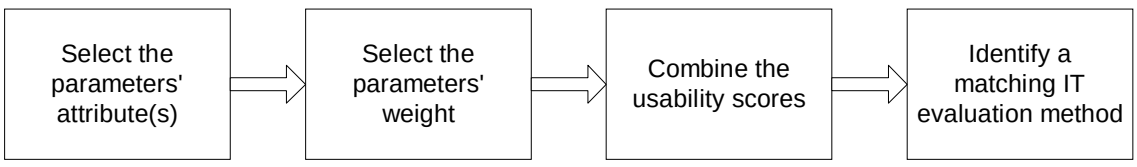

Figure 2. Procedure for completing SITEM

- **Step 1: Select the parameters' attributes**
  For each of the 21 parameters the attribute(s) that best describe the IT evaluation should be selected

(this is done by using the screens displayed in Figure 4, 5 and 6). All the parameters need to be assigned at least one attribute or else the system will not continue. The system will also detect whether there are inconsistencies in the user's choice of attributes.

- **Step 2: Select the parameters' weight**
  A weighting scale has been defined enabling a prioritisation of the 21 parameters so the company has an opportunity to decide the degree of each of the parameters' influence on the choice of method (this is done by using the screen displayed in Figure 7). The weighting scale is defined as linear as no knowledge exists indicating that another scale should be used and is represented by the following labels: Irrelevant, Little relevance, Moderate relevance, High relevance and Necessary. The last grade is indicating that this parameter's requirement(s) has to be fulfilled by the chosen method. As in step 1 all the parameters need to be assigned a weight before the system allows the user to continue.
- **Step 3: Combine the usability scores**
  Having finished steps 1 and 2, the user simply needs to activate the calculations in which SITEM is combining the user's choice of attributes, the usability scores and the assigned weight of the parameters into three scores: the total score, the number of useful matches and the number of usable matches.
- **Step 4: Identify a matching IT evaluation method**
  The last step involves a comparison of the total score of the four methods (see Figure 8). The method with the highest total score is the method (from the four methods included in the framework) that fulfils the requirement of the actual IT evaluation best. However, if the total of this method is low compared to the maximum possible then, it is possible that another of the identified 82 methods will fulfil the requirements better. In this case the framework's output indicates within which group of methods a better method should be found.

Completing the process of selecting an IT evaluation method using SITEM the user needs to go through six screens where the relevant and requested information is entered. An example showing the screens is seen in Figure 3 to Figure 8.

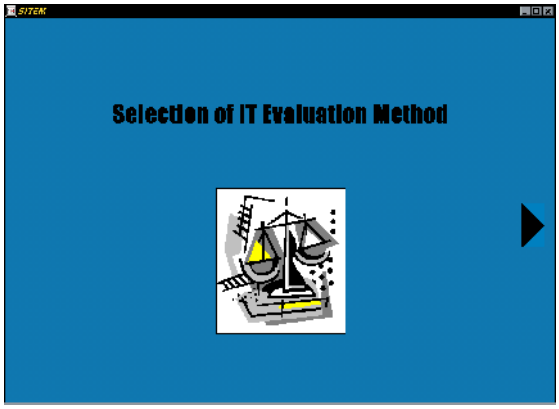

Figure 3. Title screen

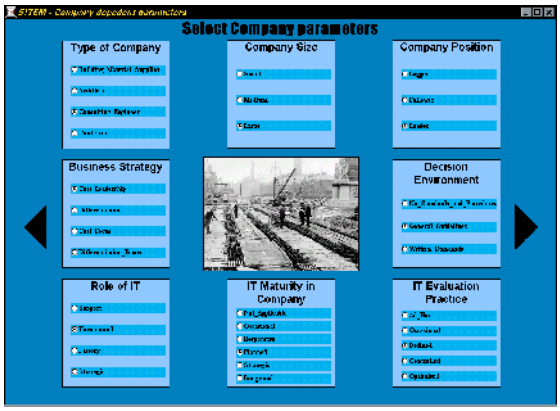

Figure 4. Selecting attributes within Company

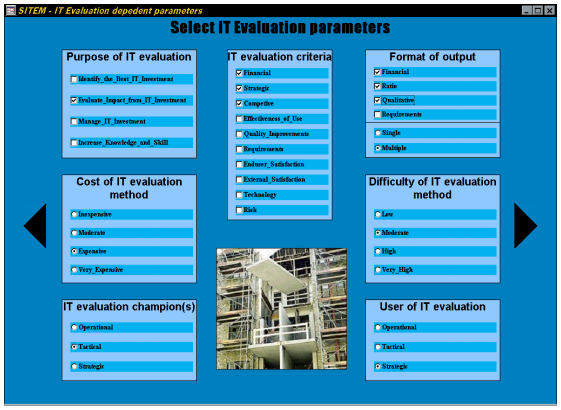

Figure 5. Selecting attributes within IT evaluation

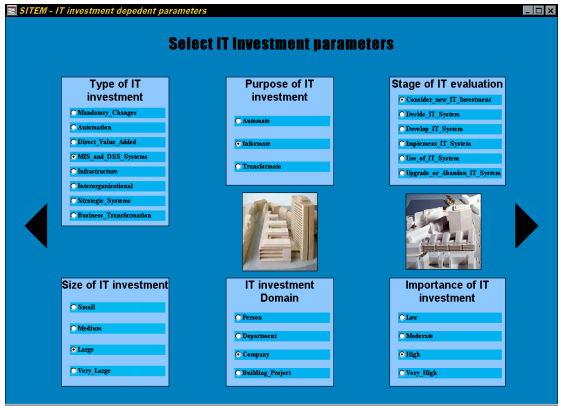

Figure 6. Selecting attributes within IT investment

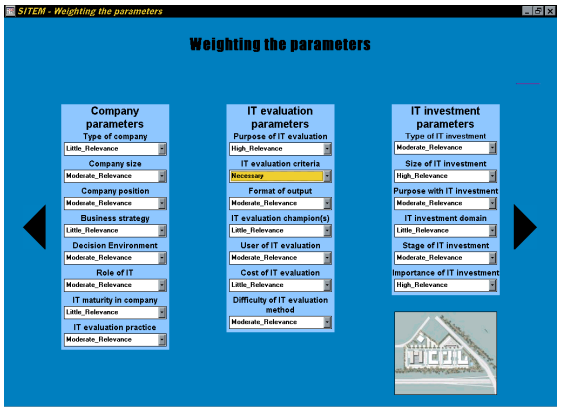

Figure 7. Assigning weights to the parameters

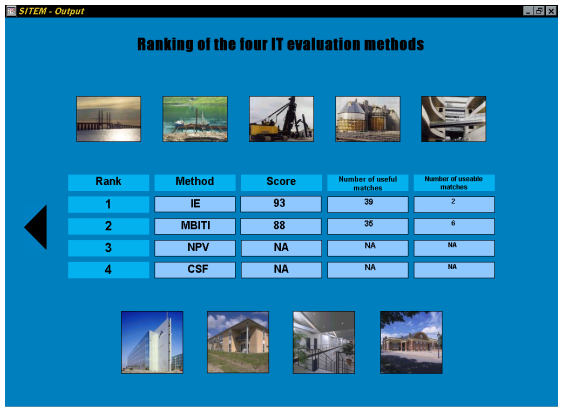

Figure 8. Presentation of the four methods' scores

Using the framework provides the user with a ranking of the four methods based on the calculations of the total score, as seen in Figure 8. In those cases where a method is not fulfilling a necessary requirement it is assigned the total score; NA (Not Applicable) and is therefore ranked lowest possible.

The user can test the sensitivity of the framework's output by either changing the choice of attributes and/or the parameters' weightings. This allows the user to simulate different IT evaluation scenarios.

Potential of the framework

The framework enables a company to select a matching method based on the characteristics of an IT evaluation. This process was earlier completed in a more randomly manner as the method was selected using less rational criteria such as 'the one we always use' or 'the one we know', whereas criteria like IT maturity in the company, type of IT investment, stage of IT evaluation etc. were rarely considered.

With the framework a company has a tool that, in an efficient and easily completed manner, guides it through the complex process resulting in an identification of a matching method. This improves the company's IT evaluation practice and will, in the longer perspective, increase the success of a company's IT usage.

The development of the framework has identified new areas of research. First, an issue not explored during the development of the framework is examining the value of an improved IT evaluation practice. Improving a company's IT evaluation practice will, firstly, lead to more objective and useful IT evaluations and, secondly, it will result in the company being better at prioritising its IT investments as the information used to derive the prioritisation is better. But how valuable is this to a company? Secondly, the work behind the framework has been based on the assumption that a formal IT evaluation is better than an informal one. However, the ideal approach has not been the subject of an analysis and therefore, if a better tool is to be developed, then this issue should be examined.

The framework, as demonstrated in the software-based version, is believed to have a commercial potential, as it will help the companies with an often-neglected problem. This potential will, however, be significantly improved if it is expanded with more methods and a guide to completing the methods.

Conclusions

This paper has presented a framework that enables a company, based on the requirements for, and the characteristics of, the IT evaluation, to select a matching method. The framework consists of three levels; a list of parameters that have an influence on the choice of method, a specification of attributes representing the conditions of each parameter and the relationship between the parameters' attributes and four IT evaluation methods. Two versions of the framework have been implemented and the software-based version is presented in this paper.

The framework can improve a company's IT evaluation practice as (a) it increases the company's awareness of available IT evaluation methods, (b) it makes the company use more formal IT evaluation methods than today, (c) the choice of method is based on rational criteria and (d) enables the company to choose a matching method.

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