OUTLINE OF A CLIENT-ORIENTED MODEL FOR ICT INVESTMENTS IN CONSTRUCTION PROJECTS

Stefan Woksepp[1] and Thomas Olofsson[2]

ABSTRACT

Most of the clients' decisions concerning the use of ICT in construction projects are taken during the procurement phase; often merely based on intuition and the immediate costs and risks the future investment is estimated to result in. As a result, the investment is always assumed to be negative since the benefits are not properly evaluated, included and weighed against the costs [and risks] the investment is expected to generate. A misleading financial estimate does not only affect the clients' decision-making in separate projects but also, in the long run, the introduction of new IT tools and processes in the construction industry.

This paper outlines a new client-oriented model for evaluating and following-up IT investments in construction projects. Basically, the intention is to provide for a work structure to be used by a multidisciplinary team to analyze the consequences of implementing a specific ICT tool in a construction project.

The structure is divided into three phases: Phase 1: "Prepare" – the work procedure is prepared and planned, and project aim and scope is established; Phase 2: "Analyze" – benefits and costs are identified, quantified, classified, evaluated, and presented; and Phase 3: "Secure" – implement, follow up, and justify future use. Although based on traditional evaluation and estimation methods the model differs as to how it is structured bringing focus on the benefits for the client. More than provide for decision-support in monetary terms, the model can provide the client with "soft and diffuse" benefits and costs (which often constitute a great contribution to the final result), insight into the construction process and the decision support the ICT can provide in terms of e.g. functionality for end users, maintenance, LCC, etc. Further development work will have to involve industrial participation and case studies to ensure the transforming the proposed conceptual model into a practical method.

KEY WORDS

Client[3], Construction projects, Decision-support, Evaluation, Following-up, IT investment.

[1] eBygg – Center for Information Technology in Construction, Dept. of Civil & Environmental Engineering, Luleå University of Technology, SE-971 87 Luleå, Sweden, and NCC Construction Sverige AB, SE-405 14 Göteborg, Sweden, Phone +46 (0)706 861839, FAX +46 (0)31 151188, stefan.woksepp@ncc.se

[2] eBygg – Center for Information Technology in Construction, Dept. of Civil & Environmental Engineering, Luleå University of Technology, SE-971 87 Luleå, Sweden, Phone +46 (0)920 491362, FAX +46 (0)920 491913, thomas.olofsson@ltu.se

[3] The "client" is the person, organization or company for whom the construction project is undertaken.

INTRODUCTION

Information and communication technology (ICT) has been widely applied across many sectors in order to increase competitiveness and reduce costs (e.g. Marsh and Flanagan 2000), and is today seen as a vehicle to gain a competitive advantage (Earl 1993, Ives and Jarvenpaa 1991).

Basically, the purpose of investment in ICT is to improve operational efficiency of an organisation so as to increase profit levels (Gunasekaran et al. 2001) as well as improve quality and reduce project time. Other (difficult to measure) effects could be (from a client's point of view) sustainable competitive advantage (e.g. Barney 1991, Henderson and Venkatraman 1999, Powell and Dent-Micallef 1997), better project control and understanding, marketing, customer service, etc. However, evaluation and justification of ICT investments is a complicated process, not only in the construction industry but also in all major industries, since cost and benefits associated with the investment are uncertain and difficult to measure (Ekström and Björnsson 2003).

Most information in construction project today is entered into computers programs or generated by software having different formats and used by the many different disciplines involved in a project, (Fischer and Kunz 2004), underlining that ICT investment is limited in scope to the benefits of the company making the investment. Early estimates, in general, are typically plagued by limited scope definition (and thus high potential for scope change) and are often prepared under time pressure (Trost and Oberlender 2003).

In order to reach a decision whether or not to use a particular ICT strategy the client has to be involved to be able to estimate whether the benefits from using the tool will exceed the costs and possible risks in the project. The growing extent of fast, complex and uncertain construction projects have made clients more susceptible to relational oriented cooperation forms such as partnering, where the client is more active regarding strategic decision-making throughout the project, (Toolanen et al, 2005). This usually involves transparent compensations models and incentives based on common goals. In these types of project decision environment an ICT strategy can be outlined to support the overall project goals.

The lack of effective and well-adapted evaluation models does not only have an influence on individual projects but also, in the long run, the introduction of new IT tools and processes. The slow transition from document-oriented information handling to an object-oriented despite the existence of many new efficient tools and processes surely illustrates the importance of having convincing incentives and well-defined implementation strategies.

EVALUATING ICT INVESTMENTS

Any major investment must be preceded by a careful investigation of its direct and indirect benefits and costs, especially ICT investments which constitutes a considerable part of a company's capital expenditure (Gyampoh-Vidogah et al. 1999). However, many construction companies often find it difficult to justify ICT investments in an industry that suffers from low profit margin (Alshawi et al. 2003). Nevertheless, the expenses for ICT systems in the construction industry continue to grow.

The lack correlation between an increased investment volume in ICT and productivity measures has been called the productivity paradox (Falk and Olve 1996). According to

Stratopoulos and Dehning (2000), this can be explained by the inability to implement necessary changes in work processes that the ICT systems are supposed to support. Brynjolfsson (1996) also addresses the difficulties to judge the benefits of an ICT investment and need for organisational changes.

Traditionally, specialists in different areas have been engaged in the task of evaluating the benefits of future ICT investments. Many times these specialists have little or no knowledge of the overall consequence of the investment. Andresen et al. (2000) describe the IT managers' large influence on the selection of data management systems on which the senior management uses to support their decision making. Specialists such as IT managers have seldom any understanding of the company's overall business goals and are often excluded from the decision-making process. The senior management on the other hand is well acquainted with the company's business but has little insight into the fast-changing ICT development and often lacks feedback from previous strategic ICT projects. Anandarajan and Wen (1999) pointed out the influence of the accountants in decisions of ICT investments. They focus on cost-benefit analyses that can be measured in monitory terms therefore lack insight on the effects on work processes that could improve the analysis of the ICT investments. Instead of making the analysis of ICT investment the task of a specific profession, general methods and tools should be developed to assist the decision-making process. Even though substantial efforts have been made to develop such evaluation methods (e.g. Chismar and Kriebal 1985, Sethi and King 1994), there is still room for improvements.

A decision of ICT investment is usually preceded by some sort of estimation of expected costs and benefits. There are several methods available. Cost Benefit Analysis (CBA) generates non-discounted estimate of benefits and costs, i.e. the cashflow, that the investment is expected to generate. Both the Discounted Cash Flow (DCF) and the Net Present Value (NPV) method calculate the net cost of the investment in monetary terms. The Internal Rate of Return (IRR) method calculates the discount rate where NPV is set to zero. NPV and IRR are basically used for the same purpose and can be viewed as complementary methods for the purpose of evaluation. Conducted correctly the IRR and NPV methods should give in an equal estimation of the effect of the investment. The above-mentioned methods are well-established and relatively easy to use. However, many users argue that these methods are difficult to apply in estimations of ICT investment, (Kumar 2000), probably due to an insufficient identification and evaluation process of benefits and costs (Powell 1992).

A CLIENT-ORIENTED MODEL FOR ICT INVESTMENTS IN CONSTRUCTION PROJECTS

BASIC ASSUMPTIONS

The primary aim of the proposed model is to provide a structure and a work routine to identify and evaluate the effects of ICT investment in a construction projects. The investment can then be realized depending on how the client judge benefits and odds for a successful implementation against the costs for the investment in the construction project. The client is presumed to play an active role in the decision and implementation, although, the ICT investment, in most cases will be used by the contractor/subcontractor rather than the client.

The model in this paper is designed to predict the outcome of a project investment involving several actors over limited time of use in contrast to "normal" ICT investments where benefits, costs and usage are identified within the company doing the investment.

The results of the evaluation model are specification, estimation, and classification of:

- Benefits expected for the client during and after the construction project have finished. The benefits are result for the client coming from the construction project (the process), use of the finished construction (product) or indirect effects as a consequence of a better construction process or product.
- Costs that are expected for the client during the project time and that are generated by the implementation and use of the IT tool during the construction project. These are organized in two categories: "Investment" and "Operational" cost.

The "Indirect" benefits also make diffuse and intangible factors visible for the decision makers that can have a major influence on the final decision. However, many of these benefits are also hard to estimate and must be classified as risky.

Maybe the most significant contribution of the model is that the target for the ICT investment is not primarily focused on reducing internal costs, but rather on generating value for the client by improving the product and the process to construct the product (Dahlgren et al. 1997).

Since the benefits of the ICT investment belongs to the owner of the project result, (the client), the costs is a project expense. This implies that the decision to invest in the ICT system must involve the client and the affected contractor/subcontractors prior to the procurement of the project. This means that the model is primarily envisaged to be used:

- In construction projects where the investment in the ICT system including the evaluation of benefits and costs are small compared with the size of the project.
- When the client is taking a leading role in planning and carrying out the project or wants to participate strategically in the construction process, e.g. through partnering.
- When the client has special demands on process/product performance such as short construction time, lower life cycle costs etc.
- When the ICT investment is effecting the working processes in the construction project.

BENEFITS

Three categories of benefits are identified; process, product and indirect benefits. Process and product benefits are improvements that can be directly related to the implementation of the ICT system. Example of process benefits are improvement of the review and decision making process, the project coordination, reliable and up to date design and schedules, minimizing waste of resources during construction and meeting projected goals on delivery time and cost by reducing project risks, etc.

A better product improves business objectives for the client. Examples of product benefits are lower energy cost, higher quality, lower maintenance cost, better functionality for the end-user etc.

Indirect benefits can be important for the client in terms of reputation or impact on third party but hard to quantify. Examples of indirect benefits are workers health and safety, more sustainable construction process (less material waste, less disturbance on the surroundings), a more environmental friendly product (recyclable, less green house gases), better support for the approval and marketing process etc.

COSTS

The costs are divided in two main categories; capital and operational costs. The capital costs consist of the up-front investment in hardware, software, integration and implementation. The integration and implementation costs can often be hard to estimate since it includes integration costs with existing software, definition and training of staff in new work routines. The operational costs are running costs of the ICT system such as administration, license fees, support and salaries of the operational staff, etc. The operational costs tend to drop since operational staff gets more effective over time.

EVALUATION PROCESS

The procedure to evaluate the cost and benefits of an ICT investment can and should be used both as a decision and follow-up tool. It is inspired by the PENG model, (Dahlgren et al. 1997), which is a becoming a popular method in Sweden to evaluate IT investment in companies and organisation. The difference is that the proposed structure has been selected to guide the client in performing an evaluation of the value and costs of an ICT investment in a construction project. Furthermore it can be argued that the method enables the client to evaluate the soft benefits, hidden costs and possibilities of the investment proposal. In the PENG model the structure is established by the group performing the analysis which means that every evaluation is unique.

The process of evaluation is divided into three phases:

- Prepare
- Analyze
- Secure

Prepare

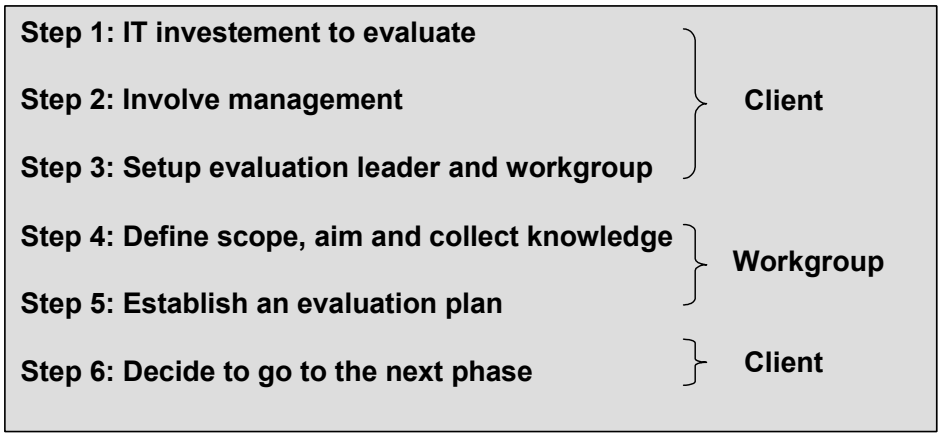
The first phase is to identify the scope of the evaluation, establish a multidisciplinary evaluation group and get management involved. The preparation phase answer questions like:

- What type of IT investment is to be evaluated?
- What's the purpose?

- Who will be affected by the investment in the project (contractor, subcontractor consultants)?

The preparation phase is necessary for establishing a group of people with a designated evaluation leader that have the competence to evaluate ICT system functionality as well the effect on work routines conducted by the various actors in the project. It is also important to involve the decision-makers early in the process. The first task of the evaluation group is to define scope and aim, describe the IT investment its purpose and effect, collect knowledge of previous use and establish evaluation plan. The first phase ends with a go or no-go decision from the management to the next evaluation phase, see figure 1.

Figure 1: Outline of the preparation phase.



Analyze

When the decision is taken to go on and analyze the effects of the investment the evaluation work group establish three checklists to identify and quantify cost and benefits and project risk with the investment.

The benefits are predefined in general terms and divided into three groups: 'Process Benefit'; 'Product Benefit'; and 'Indirect Benefit'. Each group of benefits is systematically analyzed so that no (important hidden or diffuse) values are left out. Quantification is performed in monetary terms according to the group's knowledge and experience supported by earlier evaluations. Each quantification is then classified in three grades (1 – 'Most likely', 2 – 'Likely' and 3 – 'Unlikely') according to how certain the estimates are. The result can be compiled in a predefined structure shown in table 1.

The model comes with a readily filled-in structure that can be modified if necessary. Only those benefits that directly or indirectly occur to the client are calculated.

Table 1: Structured identification and estimation of client benefits

Client Benefit					
Process Benefit		**Product Benefit**		**Indirect Benefit**	
Specify & estimate	Grade	Specify & estimate	Grade	Specify & estimate	Grade
Specify and estimate benefits that the ICT investment on the construction process (from early design to delivery) such as less construction errors, better project control & coordination, logistic, communication, design and planning, risk minimization, project time, etc	1-3	Specify and estimate benefits that effect the final product (after delivery), e.g. lower maintenance cost, better quality, less capital costs, less life cycle costs, better functionality, rebuilding, etc.	1-3	Including the - often intangible benefits - that arise from the use of a specific ICT tool e.g. competition, marketing, reputation, recruiting, new business opportunities, community planning, environmental issues, communication with authorities, workers health and safety, etc.	1-3

In order to create a workflow, the evaluation group can first identify the benefits in an unstructured way and then group them into process, product and indirect benefits. The next step can be to classify the benefits in tangible and intangible benefits. Tangible benefits are often easier to quantify such as improving energy performance or eliminating of needless work. Intangible benefits may be easy to identify, but difficult to quantify. Examples of these benefits may include aesthetics (product benefit), faster, more efficient decision-making (process benefit) where it may be necessary to involve the decision makers in the quantification process.

Identifying, quantifying and classification of the costs necessary to achieve the benefits have a process similar to that for analyzing benefits. The identified costs are quantified and allocated a grade depending on the accuracy (1 – 'Most likely', 2 – 'Likely' and 3 – 'Unlikely'). The table below shows how the costs necessary to achieve the benefits are structured. The investment costs are divided into two main groups, capital costs and operational costs. The operational costs can be further divided in subgroups such as: 'Development', 'Adaptation', 'Support and Disposal costs', 'Application costs' and 'Administration and Other costs') for two reasons. It enables easier identifying, quantifying and grading of the costs, and an easier management and follow-up of the results (presentation, administration and future use). The capital costs have been separated from the operational costs so that the client can readily calculate the depreciation time. The structure makes it easier for the client to identify where the costs occur and how much.

Table 2: Structured estimation of project costs

		Project cost	
Type of cost		Specification & estimation	Grad
Capital costs	**Capital costs**	HW, SW, Compensation, Acquisition, Other costs	1-3
Operational costs	**Development, Adaptation, Support and Disposal costs**	Personnel, Consultants, Travelling, Communication, Administration, Technical support, adaptation/ Converting, Upgrading, Other costs (includes the cost for carrying out the evaluation)	1-3
	Application costs	Personnel, Education, Communication, Workplace, Other costs	1-3
	Administration & Other costs	Personnel, Account, Security, Other costs	1-3

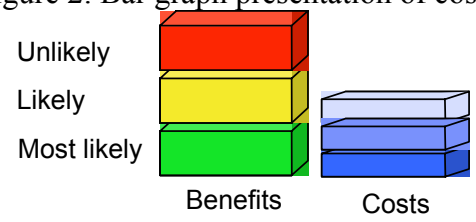
The final and maybe the most necessary step in the analysis are to identify risks with the ICT investment estimated benefits/costs. These risk needs to be noted when the potential benefits and cost are identified and estimated. For each of these risks a preliminary counter measure is produced with a preliminary time schedule and an assigned responsible person, see table 3 (Dahlgren et al. 1997). These risks are then handled by the risk management team of the project.

Table 3: Structured risk management of expected benefits and costs.

Benefit/Cost	Risk/Obstacle	Measure	Time schedule	Responsibilities
Early quantity take off	Estimators/Purchasers not involved in project at this early stage	Look over project organisation and…		
HW	Insufficient performance	Possible upgrading		
etc				

The client can after that the evaluation present the non-discounted cash flow via e.g. bar graphs where the benefits and costs are added together and specified according to the quantification grade, see figure 2. The colors represent different levels of uncertainty and it is up to the decision-maker how to interpret the distribution. The results can also be presented with one of the methods mentioned in the section “Evaluating ICT investments”.

Figure 2: Bar graph presentation of costs and benefits



Secure

The process of securing benefits begins as soon as the client decided to make the investment. Initially this consists of sharing the responsibility so that the client can secure the benefits and work on minimizing the costs and risks estimated by the use of the model. The proposed evaluation model does not contribute any special methods to help secure or minimize other than that its input structure as well as, via the use of the model, the achieved knowledge, enables the process of fine-tuning and further work. In order to achieve this requires active work throughout the entire project time.

"Secure" includes a number of activities such as: result estimation, planning before implementation- plan, secure, identify obstacles (obstacle analysis), allocation of responsibility, preparation of follow-up, etc. These additional costs are added to "Project cost".

DISCUSSION AND FUTURE WORK

This model is a plan and requires further development in order to be practically applied. To ensure an adequate development towards a practical tool, the cooperation of "experienced clients" and real projects are necessary. The next stage would be therefore to introduce a suitable collaborator and an actual construction project who has the economic interest and focus as described in the section "Client prerequisites and focuses". The first stage would be to further specify and organize the content of the model (especially the "benefit structure"), and develop the working methods to gather data as well as develop the "Secure" phase.

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