



# IT Appraisal Methods and Methodologies- A Critical Literature Review

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## ABSTRACT

The appraisal of IT investments has been a recognized problem for years, with the result that dozens of evaluation methods have been suggested by research. Despite these proposed methods, the IT valuation challenge remains unsolved in many aspects. This paper gives an overview of important method categories, and describes the evolving class of methodologies that matches particular methods with specific investment situations. While methodologies address aspects of the decision process and organizational context of an investment, critical issues remain with regard to the long-term, "enabling" nature of IT investments and the corresponding identification of required input parameters. In particular, the appraisal of IT infrastructure transformation investments is highly dependent on finding a solution for these remaining issues.

## INTRODUCTION AND CLASSIFICATION

Several researchers have given overviews of the methods available that can be applied in the process of IT investment evaluation. The methods support IT appraisal in setting objectives, generating alternatives, or valuating alternatives. Renkema and Berghout [1996] give an often-cited overview, building on results from other studies [e.g., Farbey et al. 1992; Powell 1992]. Typical characteristics of IT appraisal methods are the support of particular steps in IT evaluation processes, defined inputs and outputs, a clear structure, and generic applicability. Typically, method reviews consider only well-documented approaches that have either a sound scientific background or are, to some extent, used in practice. Most methods assess business value by weighting benefits against sacrifices (financial and non-financial) [Renkema and Berghout 1996, p. 99]. Uncertainty, flexibility, and risk are considered as influencing factors in some approaches. Based on required input parameters, different categories of methods are suggested [Renkema and Berghout 1996], i.e., financial, multi-criteria, ratio, and portfolio methods.

In the next section, we briefly introduce the most frequently used IT evaluation methods. These are clustered (Figure 1) in three major dimensions: "financial", "multi-criteria", and "strategic". The dimension "financial" covers traditional quantitative approaches; "multi-criteria" is used to cover approaches that rate IT based on defined criteria set; lastly, "strategic" reflects (long-term) planning methods. Because of the complexity involved in making long-term predictions, most of the latter methods offer qualitative predicates only. While some approaches can be clearly assigned to one particular dimension, others combine characteristics of several dimensions (e.g., the BSC method offers multi-criteria measures to support strategic planning). Recent developments like modeling and simulation (experimental methods [Farbey et al. 1999]) are not categorized; these provide prototyping approaches rather than *ex ante* valuation.

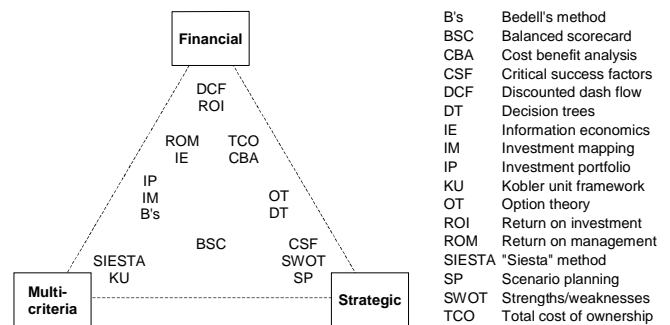
## METHODS FOR IT APPRAISAL

Renkema and Berghout [1996] found more than 65 methods for IT appraisal. By including more recent overviews [Demkes 1999; Andresen 2001; Zee 2002], over 100 methods can be identified. Powell [1999], however, found that many methods are variations of others. They are easily transformed into or reduced to other methods; hence, a description of representative approaches covers most of the characteristics of the respective category [Renkema 1999].

Financial methods estimate the expected ingoing and outgoing cash flows associated with an investment [compare Brealey and Myers 1988; Copeland et al. 2000]. DCF approaches are the most cited financial approaches, including net present value, payback period, average accounting rate of return, and internal rate of return. "Discounted cash flow techniques (...) are generally the most rigorous and defensible approaches to appraising investments. (...) DCF techniques are applied to nearly 30 percent of all information technology projects" [Weill 1995, p. 212]. CBA constitute a group of widely adopted methods for evaluating IT investment that incorporate DCF methods. The TCO method focuses on the IT cost aspects [compare Hawkins 2001].

Ratios of financial measures are often used for comparisons or benchmarking - a well-known representative being ROI. ROM [Strassmann 1990] relates cost of management to the remaining value of revenues minus full operating cost. Portfolio methods combine specific financial and non-financial criteria, and arrange graphically several possible investments. For example, Bedell's method [1985] suggests balancing the "quality" and "importance" of IT investments. The IP method

Figure 1: Overview of IT appraisal methods



[Berghout et al. (in Dutch) cited in Renkema and Berghout 1996] evaluates IT investments on the criteria of the contribution to the business domain, the contribution to the IT domain, and the financial return. Similarly, IM [Peters 1988; Peters 1994] maps investments against two main evaluation criteria: the investment orientation (infrastructure, business processes, marketing influence) and the benefits (productivity benefits, business expansion, risk reduction) of the investment. A defined set of criteria is used to appraise IT in multi-criteria approaches, whereas single criteria are rated for quantification. Cumulative scores are calculated by multiplying the weighted criteria. For example, IE [Parker et al. 1988] works as an enhanced ROI method. Adding value from other departments, improved operations, increased productivity, and innovative investment aspects extend cash flows. The SIESTA (Strategic investment evaluation and selection tool Amsterdam) approach [Van Irsel et al. 1992], for instance, is a multi-criteria method, using extensive questionnaires. The Kobler unit framework [Hochstrasser 1994] and Kaplan and Norton's BSC [Kaplan and Norton 1996] are other multi-criteria approaches that can be applied to IT.

To address the need to incorporate options and flexibility in IT appraisal, adjustments to financial approaches have been made, reflecting approaches used in strategic planning. Sensitivity analysis or adding the factor risk to the models (e.g., risk-adjusted discount rates) are common methods, while option theory has received increased attention [compare Dos Santos 1994; Benaroch and Kauffman 1999; Copeland and Antikarov 2001]. A decision tree analysis [Winston 1994] can be used for decision-making in conditions of uncertainty. It enables decision makers to break down a large, complex decision-making problem into several smaller issues. As a purely strategic (thus, qualitative) method, CSF supports the identification of the key requirements that must be fulfilled to ensure investment success [Rockart 1979]. SWOT analysis is used to find the strengths and weaknesses of the organization, as well as the opportunities and threats present in the (future) environment [summarized in Demkes 1999].

### SHORTCOMINGS AND DRAWBACKS

Despite the manifold methods proposed, a universal method that is able to value any IT initiative with a high level of confidence has not yet been found. Looking at representative methods from different categories, some commonly identified gaps can be indicated. For example, Andresen [2001] refers to a lack of guidance on how to identify or estimate the costs and/or benefits required in financial methods. The available multi-criteria methods are criticized as being hardly underpinned by theory (usually based on single case studies) [Renkema 1999]. IE, for example, calculates an abstract factor, with little intuitive content. In addition, the emerging concept of option theory has issues. It provides no support to overcome the major hurdle of identifying and estimating required cash flows and market risk distribution; it is too complex for managerial decision-making [Sharp 1991]; and it relies on unrealistic, simplified assumptions [Demkes 1999]. Furthermore, the strategic methods, if applied exclusively, do not support the quantification of value. As a consequence, empirical studies confirm that organizations have problems with the evaluation of IT investments [e.g., Farbey et al. 1992; Wiseman 1994]. Issues with the available methods for IT appraisal can be summarized according to five dimensions:

- The value of the enabling nature and long-term effectiveness of IT is barely covered, and the wide scope of IT impact is hardly captured [Renkema 1999].
- Required input parameters are difficult to identify [Strassmann 1997; Powell 1999]. "Many good investments are withheld because the benefits are difficult to assess in cash-flow terms" [Farbey et al. 1999].
- Little attention is paid to the evaluation process (e.g., identification of initiatives, valuation, decision support) [Demkes et al. 1998].
- Fixed-value metrics allow no adjustment to the organization and the specific IT investment case [Renkema 1999].

Socio-political, organizational and political, as well as collaborative organizational aspects are given little support [Hoogeveen and Oppeland 2002].

These issues have led to further developments of *methodologies* (processes on how to apply methods within an evaluation) that seek approaches to close the gaps identified.

### METHODOLOGIES FOR THE APPRAISAL OF IT INVESTMENTS

The recently proposed generic methodologies provide a structured decision-making process and support the choice of appropriate methods, depending on the decision process step, type of investment, or organizational suitability. Some of the published methodologies are briefly described in the following.

The P4 investment decision model [Renkema 1998] provides a socio-political context for the use of appraisal methods, building on the decision model of bounded rationality. Four dimensions of IT investment appraisal are introduced, "managing the product", "managing the (decision) process", "managing the participation", and "managing the politics". In doing so, P4 embeds IT assessment into a holistic organizational context. Placing more emphasis on the IT evaluation process, the COMET methodology [Demkes et al. 1998; Demkes 1999] assigns methods to different decision-making steps. The generic approach supports the entire process for the evaluation of IT investments, covering objective-setting, generation and assessment of alternatives, and choice. FIMs (future investment maps) are introduced as a combination of option theory and decision trees. FIMs are helpful to illustrate future investments that depend on an "enabling" IT investment. However, both the P4 and COMET methodologies leave the identification of specific future investments, value drivers, and probabilities open for the decision makers in a concrete case.

Farbey et al. [1999] provide an approach to match appraisal methods to the circumstances of a project. The criteria for the assessment of the evaluation role and methods are presented in a number of four-field matrices, containing aspects of tactics/strategy, decision process, certainty of impact/objectives and the role of IT. Andresen [2001] evaluates a suggested framework (consisting of a number of parameters to assess an investment situation) to determine the appropriate method for the assessment of different types of IT investments. Hares and Royle [1994] developed a methodology that targets IT appraisal and method selection from a more strategic perspective, and Zee [2002] provides an extended scorecard methodology, "BtripleE", that assesses parameters along the dimensions of business management, IT management, and IT supply management. As a rather strategic and generic approach, it does not provide a detailed decision process.

Some issues addressed in the previous section, can be solved with the methodologies described above. The approaches support structured decision processes (e.g., COMET) to address issue 3. Farbey's methodology, for example, allows the flexible choice of value metrics to target issue 4, and the P4 methodology covers considerations of the socio-political and organizational contexts of investments (issue 5). The issues with the methods, however, regarding the valuation of long-term effects, risk and flexibility, and the enabling nature of IT (issue 1) are not touched on by these methodologies, as the characteristics of the combined methods are carried forward. In addition, little is contributed to the identification of the required input parameters (issue 2).

### APPRAISAL METHODS FOR DIFFERENT TYPES OF IT INVESTMENTS

Ross and Beath [2002] suggest a categorization of IT investments along the dimensions of technology scope (business solution vs. shared infrastructure) and strategic objective (short vs. long term). Building on these categories, we classify IT investments as "use and renewal of IT infrastructure as a utility", "transactional process improvements", "experimental investments", and "IT infrastructure transformation". (Weill and Broadbent [1998, pp. 212] propose a categorization that corresponds in many aspects to these categories.) While a distribution of funds across the different categories is recommended to reflect

Figure 2: Table of IT investment categories and suggested methods for IT appraisal

IT investment category	Suggested application of IT appraisal methods
<b>Use and renewal of IT infrastructure as utility</b>	Calculation of a business case based on financial methods, e.g., DCF. Impact identification and documentation can be supported by multi-criteria methods, e.g., IE
<b>Transactional process improvements</b>	Calculation of financial impact by incorporating the quantified process improvements involved
<b>Experimental investments</b>	Budget allocation for pilot initiatives based on business strategy (driven by subjective expert judgment, experience, and intuition); can be assisted by strategic planning methods, e.g., scenario planning; quantitative value is assessed post hoc
<b>IT infrastructure transformation</b>	Available methods/methodologies are not sufficient to value IT transformation (open issues 1 and 2)

business strategy [compare Beardsley et al. 2003], prioritization within the categories needs to be according to the value of the initiatives. Depending on the categories, the requirements for appraisal methods differ (Figure 2).

Renewal of IT infrastructure (e.g., system upgrades) can leverage existing methods by conducting, for example a DCF analysis. The cash flows involved can be estimated from required additional capacity, and extrapolated from the existing cost/value of a system. Multi-criteria methods can be used to assist the identification and assessment of the related impact. Because of the short-term nature of this investment category, the capture of incremental investments is more straightforward. Transactional process improvements (e.g., the introduction of electronic forms to replace paper-based processes) are similarly accessible for valuation methods. Realizable short-term benefits can be incorporated in a business case by estimating the effects on single process steps. Experimental investments, on the other hand, are a special case. They follow long-term strategic objectives, but the uncertain experimental nature of the investments does not allow for ad hoc valuation; the effects are typically quantified as they occur. Business-level allocation of funds is consequently the approach adopted. The identification of promising experiments can be supported by strategic-planning methods like SWOT, as quantitative, ad hoc valuation cannot be sought for this category.

For IT infrastructure transformation, existing methods are less applicable than for the categories described. IT transformations target initiatives with long-term strategic objectives, e.g., ERP (enterprise resource planning) implementations. IT infrastructure transformations can be defined as follows: "infrastructure" provides IT components and shared IT functions [McKay and Brockway 1989; Weill and Broadbent 1998, pp. 26, p. 86] (applications supporting business processes are not considered infrastructure), while "transformation" indicates a major change or redirection in a company's IT infrastructure setting. As the value does not stem from the installation of a new technology, business impact based on the infrastructure (which acts as an enabler) need to be assessed. Future cash flows implied by such investments are hard to estimate, as much of the value comes from related options and future initiatives. This is one still largely unresolved issue, as valuating the enabling nature and long-term effects are weaknesses of the existing methods that make parameter identification a complex task. Unfortunately, a major share of IT spending is on IT infrastructure and related follow-up investments [Weill and Broadbent 1998, p. 82]. Consequently, the valuation of IT transformation holds potential for future research beyond the search for another method or methodology. Powell [1999] concludes, "The existence of many techniques suggests that the field is already a little crowded and that a 'new' method would be likely to add little." From our current understanding, we do not expect a generic

solution for the IT transformation valuation problem. Therefore, we recommend more context- and situation-specific research on IT transformation appraisal.

## CONCLUSION AND FUTURE WORK

Our literature search has shown that there is a lot of research in progress to find approaches for IT appraisal. An ongoing shift from the sole usage of focused methods to holistic methodologies has been observed. We found, in line with our initial assumptions, that there are few results yet for the evaluation of IT infrastructure transformations. Thus, based on specific patterns in IT transformation (e.g., life-cycle effects, the identification of enabled investments), our next step will be to deduce propositions for complexity management in IT transformation evaluation. These will be empirically tested within a long-term case-study research. The targeted outcome is a model for IT transformation valuation.

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