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Evaluation of Investments in Information Technology: Preliminary Research Findings¹

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ABSTRACT

This paper stems from a doctoral research project that studies the evaluation and prioritization of investments in information technology. It presents some preliminary research findings. First, the notions IT investment and evaluation are discussed. Second, a review and assessment of current approaches is given. Four main approaches are discerned: the finance-based approach, the multi-criteria scoring approach, the ratio approach and the portfolio approach. Finally, the paper presents some ideas about the continuation of the research project.

1 INTRODUCTION

Since the 1950's investment in Information Technology (IT) has increased considerably. IT applications have become wide-spread in management activities and production processes (e.g factory automation) and have enabled the development of new products and services. Research estimates that US firms spend about 40 to 50 percent of their annual capital expenditures on IT investment programs (Keen, 1991; Davenport & Short, 1990). And this figure does not explain the full effect: with the decrease of the price/performance ratio of IT, more IT can be purchased by the same amount of money (Diebold, 1990).

However, justification of new investments in IT appears to be more difficult than ever. Managers question the benefits of investing more and more capital in IT. Their concern is expressed by questions such as (Hochstrasser & Griffiths, 1990):

- ◆ Is IT value for money ?
- ◆ How can IT initiatives be evaluated ?
- ◆ How much is to be allocated for IT ?

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As an answer to these questions, both academicians and practitioners have proposed methods, techniques and guidelines to support management in IT investment decisions.

This paper first discusses the notions IT investment and IT investment evaluation. Second, it gives a review and assessment of current approaches to IT evaluation. Finally, some ideas about future research are given.

2 EVALUATION OF IT INVESTMENTS: DEFINITIONS AND CONTEXT

Investment levels

When considering the Cost Benefit Evaluation (CBE) of investments in IT and the way priorities are set in an investment policy, this paper discerns two levels of decision making.

The first level is about establishing the amount of resources an organization wants to spend on IT investments. A lot of organizations have a specific IT budget, from which resources are allocated to IT investment proposals. Determining a specific financial budget for IT projects is a difficult issue, since up to 40 % of relevant costs can be outside the traditional IT budget (Keen, 1991; Willcocks, 1992). Theoretically this problem could partly be solved by determining a corporate investment budget for all investment categories. Still budgeting practice often shows a separate IT budget and management has difficulties in establishing the size of the IT budget.

The second investment level deals with the question on which IT investment alternatives the available resources should be spent. Separate IT investment proposals are appraised in a CBE and investment priorities are set.

Defining an IT investment

Previously, we have been talking about investing in IT and IT investment proposals without giving a sound definition of an IT investment. IT investment is a confusing term. The term has a financial connotation. This is partly due to the meaning of the concept in the literature on capital budgeting (e.g Brealy & Myers, 1988). In capital budgeting terms an investment is defined as a capital outflow that is expected to give a net cash inflow in the future.

In capital budgeting and related disciplines, a CBE of an investment proposal only considers the cost and benefits that can be monetary valued. The notions cost and benefits of an IT investment have a broader meaning from a managerial point of view.

Costs include everything an organization sacrifices while benefits are all organizational advantages that can be attributed to the investment.

With respect to costs, Hochstrasser (1990) discerns indirect human and organizational costs from direct costs. Direct costs include the hardware, software, training and maintenance costs.

Indirect human and organizational costs are the costs caused by the transition from old to new work practices, and the management and staff time spent on successfully integrating a system into current work practices. Hochstrasser suggests that these costs might well be four times as high as direct costs. Also Keen (1991) reports about the same figure. These costs cannot easily be monetary valued.

Also the benefits of IT investments cannot all be expressed in monetary terms. Efficiency benefits such as labour force reductions can more or less be valued in a financial way. However, qualitative benefits such as competitive advantage, external integration, and enhancement of the conditions of employment are far more difficult to evaluate. For instance, the major benefits of computer integrated manufacturing as quality improvement and flexibility are benefits that are difficult to appraise financially.

Thus, the traditional, finance based definition of an IT investment is too narrow to incorporate all the possible effects of an IT investment. The definition of an IT investment should therefore consider more consequences of the investment e.g economic, organizational and technical cost and benefits. Bacon (1992) defines an IT investment as :

'Any acquisition of computer hardware, network facilities, or pre-developed software, or any 'in-house' systems development project that is expected to add or enhance an organization's information systems capabilities and produce benefits beyond the short term,...., that is, anything beyond one year.'

This definition allows many aspects to be considered. This paper will therefore follow Bacon (1992) when talking about an IT investment.

Infrastructural facilities and local applications

IT investments can be divided into different categories, based on a certain criterion, for instance on the application area (e.g. management processes versus production processes). A distinction that is quite new in the field of information systems is made by Bemelmans (1991). He claims that a major change in investing in IT will be the shift to investments in infrastructural facilities rather than investments in local applications.

Infrastructural facilities are all facilities in an organization that are for common use. Local applications are used by only one department or even individual. The infrastructural facilities are conditional for the local applications. Bemelmans discerns four main infrastructural components:

- technical facilities, like computer hardware and communication facilities;
- common databases and knowledge bases;
- common applications, like standard software packages;
- common organizational facilities, like a software engineering department and communication standards.;

Evaluation: what's involved ?

Having defined an IT investment satisfactorily, we can mark out what we mean by the evaluation of IT investments. As we will see, evaluation of an investment alternative is closely linked to the definition of an IT investment. Both have to do with costs, benefits and risks.

Evaluation is about establishing by quantitative and/or qualitative means the worth of IT and of IT initiatives to the organization (adapted from Willcocks, 1992). Establishing the worth of IT to the organization can for instance partly determine the size of the IT budget. The worth of an IT investment initiative is expressed in an assessment of the cost, benefits and risks of the investment proposal. The notion risk deserves some further explanation. The evaluation of the cost and benefits can be seen as a sort of estimation. One can never be sure of the perceived cost of benefits, e.g. by means of a detailed figure. Both cost and benefits fall in a spread of possible outcomes. This spread represents the risks of the investment.

Several factors influence the actual outcome of the evaluation. Internal factors that are worth mentioning are organizational dynamics (e.g resistance to change) and, if a system is developed in-house, system development characteristics as the programmers productivity and the nature of the information requirements (Heemstra, 1989). Also external factors influence the outcome; Clemons (1991) points out that the ultimate effects of an IT investment may differ a lot, depending on the reactions of competitors.

Of course the spread of costs and benefits can be both positive and negative. If one wants to make a realistic CBE of an investment, it is important to try to assess the possible spread of the outcomes, i.e. the risks in advance.

Evaluation in a phase model

Evaluation of in IT investment alternative is part of organizational investment planning. Figure 1 visualises the relations between evaluation and the investment process. In this figure we abstract from the budgeting problem, we just assume that an organization has limited resources.

Figure 1 presents a phase model of the different activities in IT investment planning, with respect to evaluation. The model will be explained in the remainder of this section.

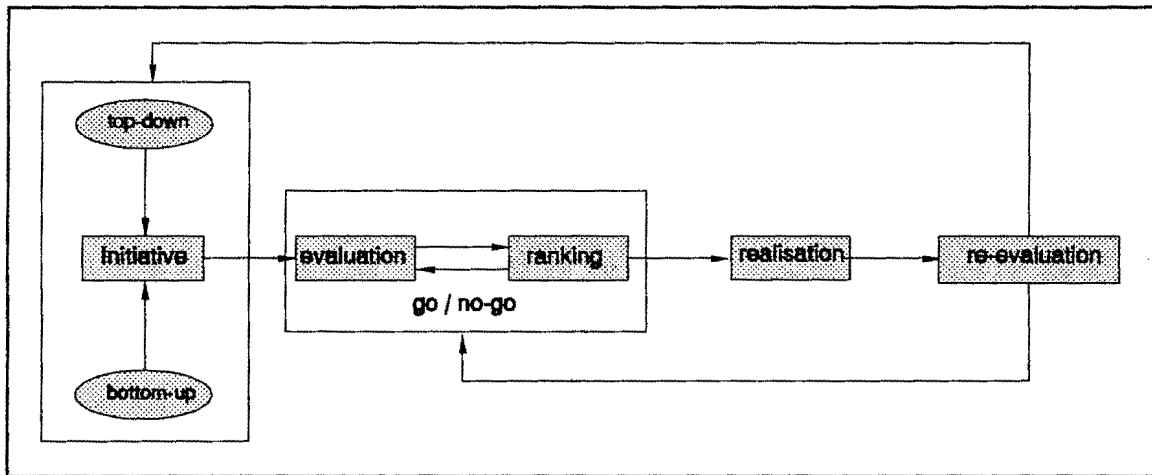


Figure 1: Evaluation in a phase model

Initiation

The process depicted in figure 1 consists of several phases. First, the origin of the investment initiative is considered. We discern between a top-down and a bottom-up planning process. Top-down refers to the planning of IT investment alternatives for the entire organization. This planning can be formalized in a planning process. Investment proposals can also be initiated by lower levels in an organization, e.g departments or individuals. We define this process as the bottom-up process.

Evaluation

The content of the evaluation activity has been discussed before. It comprises the assessment of the costs, benefits and risks of the investment alternative. Another important aspect is the process dimension of the evaluation (Symons, 1991). Usually different persons and departments are involved and together they have to reach consensus on the CBE of the investment proposal. Important stakeholders in this decision-making process are MIS-managers, end users, financial management, line management and senior management.

Ranking

In the ranking activity it is decided to which investment alternatives scarce resources will be allocated. This decision is based on the evaluation in the previous phase. These two activities have a close relationship and are often done at the same time. This is due to the fact that an investment proposal usually competes with other investment alternatives. For instance an order entry system competes with the installation of an executive information system. In this phase investment priorities are set. Although different stakeholders are usually involved, the responsibility for investment priorities can explicitly be with senior management.

Realisation

Together the evaluation and ranking activity lead to a go/no-go decision. After it has been decided to invest money in an investment alternative, realisation of the proposed investment can start. This can either be the start of a development project or the start of an acquisition.

Re-evaluation

The last phase of figure 1 comprises a re-evaluation of the investment planning process. Two arrows have been drawn. These arrows consider two important re-evaluation activities. The upper one refers to post-evaluation of the initiation of investment alternatives. The implementation of the investment may have consequences for new investment proposals, often in the form of additional investments caused by the first investment. A example is when the acquisition of a new database management system necessitates unforeseen hardware investments. The lower arrow concerns the tracking of costs and benefits after the investment and the comparison with the estimated costs and benefits. Many organizations have difficulties in doing this (Diebold, 1990) Performance measurement and re-evaluation after the initial investment, can however improve future evaluation activities. The whole process provides a learning experience for the organization. (Farbey, et.al., 1992).

3 A REVIEW AND ASSESSMENT OF CURRENT APPROACHES

Current approaches

The preceding section defined what investing in IT is about and gave the necessary context for studying the evaluation of IT investments. Figure 1 presented a visual representation of the investment process, related to evaluation.

Numerous methods have been proposed to support the evaluation of IT investments and to improve decision-making on IT investments. This section gives an overview of the most important methods that are currently available. We first describe four approaches, in which most methods can be classified. Second, we assess the approaches on several criteria.

Several authors give a classification of existing IT evaluation methods (e.g. Diebold, 1990; Farbey, et.al., 1992; Willcocks, 1992). After studying the literature on IT investment evaluation, we distinguished four main classes or approaches. These are successively :

- 1) The finance-based approach
- 2) The multi-criteria scoring approach
- 3) The ratio approach
- 4) The portfolio approach

1) Finance-based approach

Finance-based methods are widely used in the literature on capital budgeting (see section 2). Brealy and Myers (1988) mention the following methods: the payback method, the discounted payback method, the average return on book value, the internal rate of return method, the net present value rule and the profitability index. We will not discuss these techniques in full extent. On theoretical grounds, the capital budgeting literature prefers the subclass of Discounted Cash Flow or DCF methods, in particular the Net Present Value (NPV) rule. The NPV rule evaluates the future cash flows against a discount rate in order to get the present value.

The traditional techniques in capital budgeting can be extended with other financial techniques as the hedonics wage model and break even analysis (Sassone 1988). The finance-based methods are very pervasive in IT investment evaluation. They are often prescribed for the evaluation of all corporate investments.

2) Multi-criteria scoring approach

Multi criteria scoring methods discern several evaluation criteria. A score is given to every criterion. In the end, a weight is assigned to all criteria. The final score is found by combining the different scores and weights. By ranking the final scores an organization can set investment priorities. Usually there are no standards for the scores and weights given.

The user of the method has to design a list of the available scores and should establish the relative importance of the different criteria by assigning weights to them. We will give two examples of scoring methods.

The Enterprise Wide Information Economics (EWIE) method of Parker en Benson (1988, 1989) incorporates a wide range of evaluation criteria. The enhanced Return on Investment (ROI) is a financial assessment as proposed by the finance-based methods (see 1) In this assessment the traditional DCF evaluation, is extended with some additional financial techniques. Parker en Benson separate the business domain assessment from the technology domain assessment. Both domains include several criteria, that can be valued positively (benefits) or negatively (costs and risks). End-users, MIS-management and business management have to reach consensus on the scores and weights.

Wissema (1985) discerns four different criteria. The first criterion is a discounted cash flow evaluation. Second, the extent in which synergy can be achieved by clustering business activities is assessed. The third criterion considers the affinity to the strategy of the firm. Finally the method of Wissema takes the external, societal acceptance into account.

3) Ratio approach

Ratio methods relate one aggregate IT figure to another aggregate figure. Examples are: total IT expenditure against total revenue and IT costs per employee (Farbey et.al., 1992). A ratio method that recently received a lot of attention, is the Return on Management or ROM method by Strassman (1990).

In the ROM method the value of an IT investment is seen as the contribution to the level of management productivity. ROM is calculated as follows. The figure that remains after deducting from gross revenues all costs of resources, e.g. labour and capital is called management value added. This divided by management costs leaves the ROM ratio. When using the method, one has to accept the assumption that all IT value falls within management productivity. This assumption can be challenged by (see e.g. Symons, 1991).

4) Portfolio approach

Portfolio methods are used to plan and balance different IT investment alternatives. The portfolio approach is widely used in other business disciplines. For instance to balance risk and profitability of securities or to balance product/market combinations.

In the realm of IT investment evaluation, we will discuss two examples of portfolio methods.

Bedell's method (1985) relies on a central assumption. This assumption holds that an IT investment alternative earns a high investment priority when the importance to the organization is high and the quality of the system that is currently in use is low. The method discerns several levels of assessment: organization, activities, functions and information systems. In several steps scores are assigned to indicators, reflecting quality and importance. There are some standards for assigning scores. The scores are used in calculations. For priority setting, the financial costs also have to be assessed.

Information planning methods are essentially methods for designing the information systems support for an organization (Stegwee 1992). Well-known methods are the Business Systems Planning and Information Engineering methods. These methods design an information architecture and ensuing project portfolio on the basis of business plans and technology trends (see also Earl, 1989). The architecture consists of information systems and the relationships between them. Information planning methods are data-oriented: the information architecture is based on the relationship between data and business activities.

The different approaches and accompanying methods can be extended with less structured ones, for instance the guidelines proposed by Clemons and Weber (1990). The four approaches discussed above, cover most of the work done on methods for IT evaluation.

Assessment of current approaches

The proposed approaches and methods all have its characteristics with respect to investment planning and the evaluation process. As part of our research project we are assessing the different methods for IT evaluation on several criteria. The aim is to design a framework for positioning all existing methods. Visually this will look like table 1. This table is simplified by assuming a total of 3 methods and 3 criteria. Only after having investigated all available methods and having designed of a coherent set of criteria we will be able to give a full assessment.

| CRITERIA | | | |
|-----------|-----------------------|--------------|--------------|
| METHODS | criterion #1 | criterion #2 | criterion #3 |
| method #1 | ASSESSMENT OF METHODS | | |
| method #2 | | | |
| method #3 | | | |

Table 1: A framework for positioning evaluation methods

This section gives some preliminary results. It only considers the approaches we have discerned and four criteria. We will discuss the criteria separately. Every criterion has been divided into subcriteria. The boxes give the assessment of the different approaches. It is also indicated if a criterion is not relevant for an approach.

1 IT Investment levels

In section 2 we discerned two investment levels. The first level concerns the amount of resources an organization wants to spend on IT. This level is often reflected in a budgeting decision. The second investment level concerns the decision on which investment proposals the resources will be spent. In table 2 the latter has been called project level and the former organizational level. The boxes indicate whether the different approaches give any methodic support on the two levels of investment.

| IT INVESTMENT LEVEL | | |
|---------------------|----------------|---------|
| CLASS | organizational | project |
| Finance based | No | Yes |
| Multi-criteria | No | Yes |
| Ratio | Yes | No |
| Portfolio | Somewhat | Yes |

Table 2: Methodic support on the IT investment levels

Explanation:

The finance-based approach and the multi-criteria scoring approach only consider separate investment alternatives. Both approaches cannot be used for decision-making on the allocation of resources to investment categories.

The ratio approach can assist in decision-making on the amount of resources an organization wants to spend on IT. The use of ratios gives information in several ways. First, historical figures and trends give an indication of the importance of IT to the organization. Second, the ratios can be compared with other ratios, for instance with ratios of other investment categories (e.g. training programs, marketing campaigns) and of competitors. These comparisons can be used for deciding the relative amount of scarce resources the organization will spend on IT. Strassman (1990) points out that the ROM method can be used for the evaluation of separate investments. The value of the investment is calculated as the difference between the ROM ratio with and without the investment. Besides methodological problems (e.g. causality) this can only be done after the investment has been implemented. This is what we call post-evaluation. Hence, the ROM cannot be used for the evaluation of a separate investment proposal.

The portfolio approach balances different investment alternatives or projects. It thus takes the project level into account. For instance in information planning methods, the different project proposals are balanced in a project portfolio. Portfolio methods can however give indications of the relative importance of IT to the organization. Bedell's method (1985) explicitly uses indicators to assess the current and potential effect of information systems to the organization. If an organization has indicators of the importance of other investment categories, the relative importance of IT can be assessed. The organization can use this information in the allocation decision on an organizational level. However, the problem is to find indicators for the other investment categories that are comparable to the indicators of Bedell. The discussed portfolio methods only consider IT related indicators and the importance of IT.

2 Planning orientation

When discussing the origin of an investment proposal in section 2, we discerned between a top-down and bottom-up planning process. (see also figure 1). Table 3 presents the planning orientation of the different approaches.

| | | PLANNING ORIENTATION | |
|----------------|--------------|----------------------|--|
| CLASS | top-down | bottom-up | |
| Finance based | No | Yes | |
| Multi-criteria | not relevant | | |
| Ratio | not relevant | | |
| Portfolio | Yes | No | |

Table 3: Planning orientation

Explanation:

The multi-criteria approach and ratio approach do not pay attention to the orientation of the planning process. The methods of the finance-based approach generally assume that investment proposals are initiated from different places in the organization, so the planning orientation is bottom-up. Verhaegen (1986) who studied the capital budgeting process of large, diversified companies, claims investment proposals are mainly influenced by local circumstances. Local departments submit investment proposals and by evaluating the separate proposals, the worth to the organization can be assessed. The decision to allocate resources to the investment proposal is with senior management. Verhaegen refers to Bower (1970) when he grounds the bottom-up orientation of the planning process.

The portfolio approach has a top-down orientation. It considers the entire organization and plans the investments organization-wide. For instance information planning methods promote top-down, organization-wide data planning. The methods take the view that data is a corporate resource, and therefore should be planned on a corporate-wide basis (Stegwee, 1992).

3 Evaluation domain

In section 2 we defined the notion IT investment. We preferred Bacon (1992) his definition, because it allowed many aspects to be considered. It was argued that both the economic, organizational and technical aspects should be taken into account. Table 4 discerns three evaluation domains, reflecting the different aspects. The boxes assess whether the different approaches take aspects from the discerned evaluation domains into account. This means that costs, benefits and risks of a proposed investment can be expressed in terms ensuing from the three evaluation domains.

The economic domain considers all business aspects that can be monetary valued, for instance purchasing expenses, personnel salaries and work force reductions. The organizational domain refers to all business aspects that are perceived as cost, benefits and risks, but cannot be monetary valued. Examples are the indirect human and organizational costs (see section 2) and benefits such as quality improvement, competitive positioning and enhancement of the conditions of employment. The technological domain covers all technical aspects. These include hardware characteristics, the way telecommunications systems are implemented and software maturity and capabilities.

| CLASS | EVALUATION DOMAIN | | |
|----------------|-------------------|----------------|---------------|
| | economic | organizational | technological |
| Finance based | Yes | No | No |
| Multi-criteria | Yes | Yes | Yes |
| Ratio | Yes | Yes | No |
| Portfolio | No | Yes | Yes |

Table 4: Evaluation domain

Explanation:

The finance-based approach only considers the economic domain. Many finance-based methods originally stem from economic disciplines and variants are still used in for instance welfare economics (Sassone en Schaffer, 1978).

The multi-criteria scoring approach can cover criteria from all evaluation domains of table 4. The amount of criteria a multi-criteria scoring method can take into account is unlimited. The EWIE method of Parker & Benson (1988,1989) considers aspects from all three evaluation domains. The three domains are successively considered in the enhanced ROI evaluation, the business domain assessment and the technological domain assessment. The method of Wissema takes the economic and organizational domain into account.

The ratio approach does consider economic and organizational aspects, but pays hardly any attention to technological issues. The ROM method for instance focuses on the management productivity.

The ROM ratio relates management value added to management cost. A ratio that explicitly considers the organizational domain is the ratio IT costs per employee.

The portfolio approach to evaluation does not consider the economic domain. Portfolio methods often use qualitative notions, ensuing from the organizational and technological domain. Information planning methods do not try to value all proposed investments monetary. IT investments, commonly supposed development projects, are justified on the basis of the designed information architecture and technological possibilities. Bedell's method tries to find investment priorities with arguments as organizational importance and quality of the implemented information systems.

4 IT orientation

In section 2 a distinction between was made between investing in infrastructural facilities and local applications, following Bemelmans (1991). The orientation of the proposed investment can be towards extending the infrastructural facilities or towards a local application. In Table 5 this is called the IT orientation. The boxes of table 5 assess whether the different evaluation classes cover the two IT orientations.

| CLASS | IT ORIENTATION | |
|----------------|--------------------|----------------|
| | local applications | infrastructure |
| Finance based | not relevant | |
| Multi-criteria | Yes | Somewhat |
| Ratio | not relevant | |
| Portfolio | Yes | No |

Table 5: IT orientation

Explanation:

The distinction between an infrastructural orientation of IT investments and investments oriented towards local applications, has no meaning for the finance-based approach and ratio approach. The methods in these approaches do not discern between IT investments, when evaluating the proposed investment.

The multi criteria approach somewhat discerns between infrastructural investments and investments to install local applications. However, the known methods are mainly oriented towards local applications. But infrastructural elements are not totally neglected. For instance, Parker & Benson's EWIE method considers the criterion IS infrastructure risk.

However, the EWIE method treats infrastructural issues only as technical issues and does not pay attention to the managerial and business consequences. Infrastructural facilities are for common use and therefore they have great managerial consequences.

Methods from the portfolio approach are only oriented towards local applications. For instance information planning methods divide the organization into distinct processes and information system areas. Also Bedell's method distinguishes activities and functions and separate information systems. These information systems are local applications.

4 FURTHER RESEARCH

We have presented some preliminary results of the doctoral research project. This section gives some ideas about the continuation of the research.

An exploratory field study

Researchers have put a lot of effort in designing methods for the evaluation of investments in IT. However, little is known of evaluation practices and actual decision-making on investments in IT. This is especially the case for Dutch organizations. To gain more insight in the way evaluation is carried out in practice, we will conduct an exploratory field study in a number of Dutch organizations. The field study covers organizations from several sectors, like government departments, financial institutions and industrial concerns. We will interview business managers that are responsible for IT affairs. Main points of interest are:

- the methods used and the problems encountered when using them;
- the way IT investment evaluation is related to the investment planning;
- the persons and departments involved in the evaluation process and their task and responsibilities;
- the perceived differences between infrastructural facilities and local applications.

Future results ?

Further results partly depend on the results of the field study, but some general points can be made. After studying the literature on the evaluation of IT investments (see section 3), we saw two points that deserve attention:

The generic nature of existing methods

The currently available methods for the evaluation of IT investments are of a very generic nature. Some are prescribed for all corporate investments, such as methods of the finance-based approach. Others are prescribed for all IT investments. However, a method will be used in a specific organization and for specific investments. Our assessment of the current approaches gives some indications for the use of specific methods. The criteria used, reflect organizational and investment characteristics. Several authors have tried to match the methods to situational characteristics (Hochstrasser, 1990; Farbey et.al., 1992). However, a consistent framework is missing. Research on IT investment evaluation could make great progress by matching methods and combinations of methods to specific situations. Important situational characteristics are:

- the sector of the organization (e.g public versus private);
- the organizational structure (e.g departments, persons and responsibilities);
- the culture of the organization (e.g formal versus informal);
- the importance of IT to the organization;
- prior evaluation experiences;

Infrastructural facilities

Up till now, little attention has been paid to the evaluation of investments in infrastructural facilities. Option theory (Dos Santos, 1991; Carlson & McNurlin, 1992) might contribute to the evaluation of these investments. As future investments may often be oriented towards infrastructural facilities (Bemelmans 1991), more research on the evaluation of these investments is needed.

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