Managing the information infrastructure for business value

MANAGING THE INFORMATION INFRASTRUCTURE FOR BUSINESS VALUE[1]

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Abstract

Evaluation and management of IT investments have come to play an essential role in the corporate success of contemporary organisations. Senior management's prime concern has shifted from controlling IT costs to managing and delivering IT benefits. An emerging notion in the successful exploitation of IT is that of an information infrastructure. The research discussed here, examines the precise role and implications of this infrastructure. Building on this, it provides guidelines with respect to the decision-making process underlying investments in the information infrastructure. The ultimate aim of the research is to increase the business value to be obtained from infrastructure investments.

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1 Motivation and research questions

Throughout the last decades, organisations have become increasingly dependent on information technology (IT) in their search for corporate success and survival. Until recently, IT was mainly used to rationalize routine business processes. The main thrust was to improve efficiency through cost savings and cost displacements. In this day and age, long-term business investments are made with the purpose to improve effectiveness, to gain and sustain competitive advantage and to transform entire business processes.

The widespread use of IT has made that in many cases IT investments attach a major and increasing part of the available financial resources. It is estimated that today, large organisations spend up to 50% of their capital expenditures on IT [2, 8, 11]. Recently, increased emphasis has been put on the role of infrastructure investments in order to get the full benefits of large scale IT deployment. (see e.g. [3, 13, 19, 27, 32, 34, 37, 38, 40]). Various sources point out that the infrastructure part of IT capital expenditures might well be 35% [19, 24]. Infrastructure investments closely relate to what has come to known as an information infrastructure. There is however a lack of clarity with respect the precise nature and role of this information infrastructure. This obviously inhibits the increased attention for infrastructure investments which is called for.

The value for money to be obtained from the apparent massive IT investment is far from guaranteed. IT investments have repeatedly been the subject of disappointed expectations and their evaluations raise many questions (see e.g. [1, 7, 16, 42, 44). The general investment climate towards continued IT investment has also been affected by the IT 'productivity paradox'. This notion refers to the observation that economic data give no conclusive answer as to what the contribution of IT to organizational performance is. (for a review see [6, 41]).

This productivity paradox also has its managerial counterpart. In the light of the many controversial findings regarding the impact of IT on business performance, senior management has become highly unreceptive towards 'act of faith' investment decisions. Today, senior management is expressing an urgent need for more concrete, sound evidence of the expected business impacts of proposed IT investments. The assessment of such impacts is however easier said then done. Costs are still difficult to estimate and often hidden, benefits are difficult to quantify and measure, and the uncertainties and risks are often substantial. The paradoxical situation arises from the conviction of many managers that IT investments, although difficult to justify, do play an essential role in the achievement of their corporate strategies. Not investing in IT might severely jeopardize their organization's future viability. Keen [19] expresses the dilemma many senior managers face as: 'Senior executives are caught in a worrisome double bind (...); economically, companies cannot afford to increase capital spending on IT; competitively, they cannot afford not to do so. The economics of information capital is firmly on the top management agenda, and corporate managers are clamoring for help.'

It can be expected that, regardless of any specific view of an information infrastructure, these difficulties also have relevance to the evaluation of infrastructure investments. When considering infrastructure investments, the recent evaluation literature claims for instance that these investments are particularly difficult to

justify because of their long term, indirect business benefits [28, 12] and suggests the use of option theory [10, 18].

The ultimate aim of the doctoral research presented here, is to increase the business value an organisation is able to obtain from its infrastructure investment. It addresses two research questions:

- What exactly is an information infrastructure, and which role does this infrastructure play in the successful exploitation of IT?
- Given this view of an information infrastructure, how can investments in the information infrastructure be evaluated and the underlying decision-making process be managed?

2. Research methodology

2.1. Inputs for the research

The methodology employed is this research combines theoretical research and empirical work. The *theoretical basis* can be characterized as interdisciplinary, using sources from the information systems (IS) and evaluation literatures as well as several reference disciplines. The *empirical design* of the study consists of a survey, case studies, group brainstorming sessions and, preferably, a field experiment.

The data for the first three empirical sources are for the larger part provided by the Dutch branch of a insurance multinational with its headquarters in the Netherlands. This organisation has given us the opportunity to do as much action-oriented research as possible. This means that there is full access to infrastructure and IT investment related information. Although this research orientation has its drawbacks in terms of the 'harder' traditional academic standards (e.g. replication, statistical generalisation) it yields much more relevant in-depth research findings. This allows for insights and guidelines that are more applicable to investment decision-making practices.

2.2. Research perspective

Investment evaluation is above all looked upon as a largely communicative decision-making process. It is not 'a method of pinning numbers on things to prove or disprove a case' [12, p. VII]. This decision-making process involves multiple stakeholders, who are through mutual consultation trying to assess the future value to be gained from a proposed investment. The product of such a process provides the crucial standards against which the investment's business value can be measured and managed across it's life cycle.

The research perspective taken captures both the goal (or, in our terms: product) and process dimension of strategic decision-making (a distinction made by Idenburg [17]), thus leading to a more balanced control of investment decisions. Table 1 visualises the adaption of the Idenburg model to the field of IT investment

evaluation[2]. Without any structuring on the product or process dimension, investment decisions will amount to 'act of faith' decisions, a situation that has become unacceptable in the present IT investment climate. Too much structuring on the product decision will lead to 'rational comprehensive planning' [33]; i.e. trying to quantify as much aspects as possible, thereby ignoring the much more complex and uncertain organisational reality decision-makers face. The many finance-based evaluation methods are product-oriented, by concentrating on the consequences of IT investments that can be monetary valued. An exclusive focus on the process dimension does not account for the essence of organisational decision-making: stating objectives and, given scarce resources, choosing between alternatives to reach these objectives. This implies that an investment decision merely is regarded a learning experience. Structuring of decision-making is aimed at learning the involved stakeholders to arrive at a decision (e.g. trough building 'mental models'). Providing them with relevant decision criteria to evaluate and choose between investment alternatives, falls beyond the learning focus.

The present research advocates a more balanced approach towards the evaluation and management of IT investment decisions, what we in table 1 refer to as 'balanced control'. It is aimed at structuring IT investment evaluation, specifically that of infrastructure investments, trough a dynamic alignment of both the product and process dimension. At the heart of any evaluation lies the establishment of a set of investments arguments to assess the business impacts of the investments. This establishment does, however, not take place in isolation. It's is the outcome of a communicative process between involved stakeholders.

process dimension		*product dimension*	
strong		Learning Experience	Balanced Control
weak		Act of faith	Rational planning
		weak	strong

Tab. 1. *The product and process dimension of investment evaluation (adapted from [17]).*

[2] Idenburg refers to logical incrementalism as the intellectual base for strategy formation that both takes the goal and process dimension of strategic decision-making into account. No structuring on either dimension leads to 'spontaneous' or 'emergent' strategies.

3 The nature and role of the information infrastructure

3.1. The rise of investments in the information infrastructure

The notion 'infrastructure' is not entirely new in the IS field. In the IS literature the term 'infrastructure' is being used in a variety of meanings, usually without defining or delineating it too narrowly.

Until recently the notion infrastructure merely had a rather narrow, technological connotation, generally referring to the centralized computing equipment. In this 'traditional view' [30] an infrastructure is considered to include all facilitative resources in the field of technology, often organized in a centralized information systems department. This encompasses all technological means such as mainframe computers, data communications equipment and operating systems. Also the personnel (e.g. operators and system designers) and organizational procedures in the IS department are seen as part of the infrastructure (see for a comprehensive overview [22]). Maes [23] contends that through this primarily technological view the notion infrastructure has entered the IS field and therefore still has a rather technological connotation. A recent definition of an infrastructure that falls within this view is the one by Weill [40 p.553]: 'the base foundation of IT capability budgeted for and provided by the information systems function and shared across multiple business units or functional units. The IT capability budgeted for includes both the technical and managerial expertise required to provide reliable services.'

A more modern view uses the notion of an infrastructure in a broader sense, often referred to as an information infrastructure. This information infrastructure has been drawn to attention from notably two directions.

First of all, the information infrastructure has emerged as a focal point of national or even international IT policies. From this perspective, infrastructure investments are seen to provide the telecommunications-based 'information super highway' that allows for the interconnection of and communication between individuals and organizations on a grand scale. Questions surrounding the feasibility and societal impacts of such an infrastructure have also been the subject of considerable public debate.

The notion of an information infrastructure has also gained prominence as a key element in the strategic management of information technology. From an organisational level perspective, it is advocated that organisations should direct their IT strategy towards building and maintaining an information infrastructure [3, 4, 13, 19, 37, 38] From this perspective, management of this information infrastructure serves as an alternative to the approach embedded in the more classical strategic planning methodologies (e.g. BSP, ISP). These methods are aimed at the organization wide, top-down planning and prioritization of the IT applications portfolio.

What both perspectives on the information infrastructure have in common, is that they stress the increasingly shared, coordinative nature of IT investments. A comparison can be made with public infrastructures such as roads, public transport and facilities in the fields of education or social services. The users of such an information infrastructure have, together with many interested persons or parties, a whole range of IT based services at their disposal. The user also has substantial degrees of freedom; the infrastructure provides the base foundation that enables the subsequent local application of IT, tailored to one's own characteristics and prefer-

ences.

3.2. Survey findings

A survey was conducted in which the respondents view of an (information)-infrastructure was asked for. Eighteen people participated in the survey, of which thirteen were employees of the case study organisation. The survey data show that:

- The emphasis on the nature of infrastructure flows into two main directions:
  - Infrastructure as a coherent system of all organizational IT resources;
  - Infrastructure as a system of technological facilities, with specific references made to developments in the fields of networks and data communications;

  The respondents working in a centralized IT department slightly preferred the second line of thought.
- An element which was considered of increasing importance was the improved organizational communication enabled by the information infrastructure. This improved communication had its impact both internally (between persons and departments) and externally (linking with customers).
- It was emphasized that an information infrastructure should be structured according to the needs of its customers (end users). Business needs, not technology should be the driving force.
- Several respondents pointed out that wider organizational arrangements are of great importance to the information infrastructure. Examples mentioned are data standards and data procedures, but also an explicit management vision of the role of the infrastructure.

3.3. Definition; direct and indirect infrastructure

Building on the literature review and the empirical findings, an information infrastructure is defined as:

'The shared system of people, non human resources and organizational procedures in the field of information technology, that an organization has it its disposal for the longer term'

A further distinction is made between investments in the *indirect infrastructure* and investments in the *direct infrastructure*. The indirect infrastructure includes the technological and organizational facilities. This infrastructure enables the use of the direct infrastructure, that comprises the infrastructures of data, applications and knowledge. The direct infrastructure is generally to a large extent integrated with the business processes. The benefits of the direct infrastructure are therefore much more direct that those of the indirect infrastructure.

Currently, this definition is transformed into a descriptive model that gives an overview of the components in more operational terms. It is planned to develop and apply this model in three case studies on several organisational levels of the case study organisation. Table 2 gives the basic structure of the model as it result from the preliminary results of the first case study.

The model primarily serves as a modelling language to set the stage for

investment evaluation. It can be used to generate new investment initiatives and to assess the likely impacts of proposed investments on the shape and contents of the infrastructure. An important element in this model is the relative character of the notion organization, that leads to a layered model of the infrastructure (see figure 1). It is also suggested that an information infrastructure partly originates from components imposed by a higher level and components that are used commonly through lateral agreement.

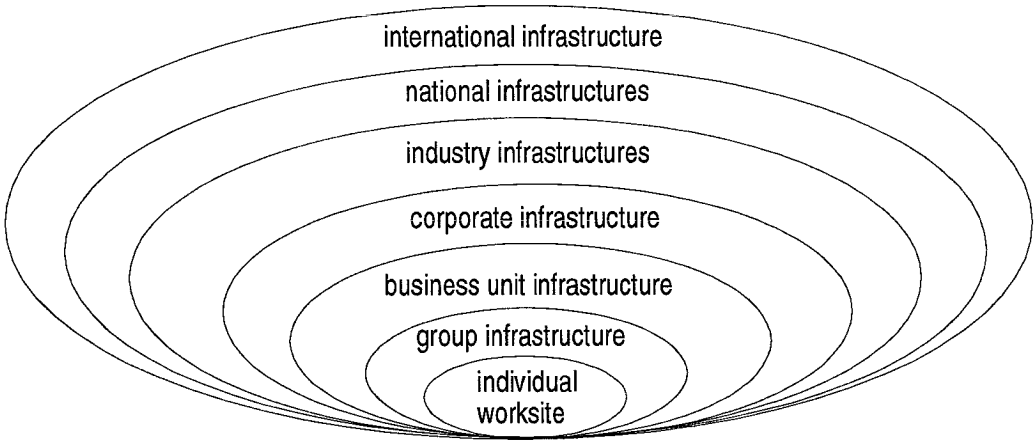

Fig. 1. The layered nature of the information infrastructure

4 Evaluating and managing infrastructure investments

4.1. Methods and insights

Evaluation and management of IT investments is not a new phenomenon. A study of the evaluation literature revealed that there is a plethora of methods for IT investment evaluation. Over 65 were identified, that all aim to be of help to the evaluator [31]. Four basic categories can be distinguished: financial methods (e.g. payback time and internal return), multi-criteria methods, portfolio methods and ratio methods.

Referring to the type of investment considered, the literature generally applies to all IT investments. The focus is however on end-user applications for a single identifiable organizational unit. Infrastructure investments (in terms of the previous section, investments in the indirect infrastructure) are considered as difficult to evaluate and it is suggested that option theory might be of help [10, 18].

DIRECT INFRASTRUCTURE		
Shared applications, databases and knowledgebases	a) b) c) d) e)	Legal compliancies (e.g. financial reports, external auditing) Shared resources (e.g. finance, personnel, production facilities) Production and logistics (e.g. R&D, purchasing, production processes and inventories, distribution) Marketing and Sales (e.g. Clients, market research) Communications (internal; e.g. mutual transactions, electronic mail and external; e.g. communication to suppliers, clients, industry partners)
Standardized applications, databases and knowledgebases	a) b) c)	Products/Services (e.g. embedded software, chipcards and smartcards) Production processes (e.g. material requirements planning software) Office work (e.g. word processing, desk-top publishing)
Data management and application management	a) b) c) d) e) f) g) h) i)	User manuals System access authorizations Input/output procedures and authorizations Data definitions Data models Functionality descriptions of applications Application owners and responsibilities Information architecture models Procedures for signalling changes of a) to h)
INDIRECT INFRASTRUCTURE		
IT strategy and planning	a) b) c) d)	Strategic planning methods and procedures Steering committee and corporate planners Procedures for IT investment evaluation and prioritization Contractprocedures (e.g. cost allocations and service level agreements)
Systems development and maintenance	a) b) c) d) e)	Projectmanagement Information analysis and systems design Systems realisation and testing (in-house development) Software package selection and procurement System conversion and implementation
Systems operations	a) b) c) d)	Hardware and systems software Database software Operations management (e.g. quality management, change management, problem management) Security and calamity management
Communications	a) b) c)	Networks (e.g. WAN, LAN) Communications hardware and software Network architectures and procedures
Systems support and training	a) b)	Helpdesk and PC support Training plans and facilities

Tab. 2. A descriptive model of the information infrastructure

While the focus of existing methods is on providing relevant evaluation criteria, there is also the interpretive perspective in the literature (see e.g. [15, 36, 39]). The interpretive perspective draws the attention away from evaluation criteria

and on to wider organizational and political issues.

4.2 Managing the decision-making process

The aim of any investment evaluation is to improve and facilitate decision-making on investments. This has lead us to believe that we need an explicit view of investment evaluation as a decision-making and largely communicative process. To develop this view, a framework of investment evaluation was designed. Four aspects are distinguished that can all four be used to improve the investment evaluation and to manage the underlying decision-making process. Figure 2 summarizes the four aspects, while the remainder of the section provides a further elaboration of these aspects.

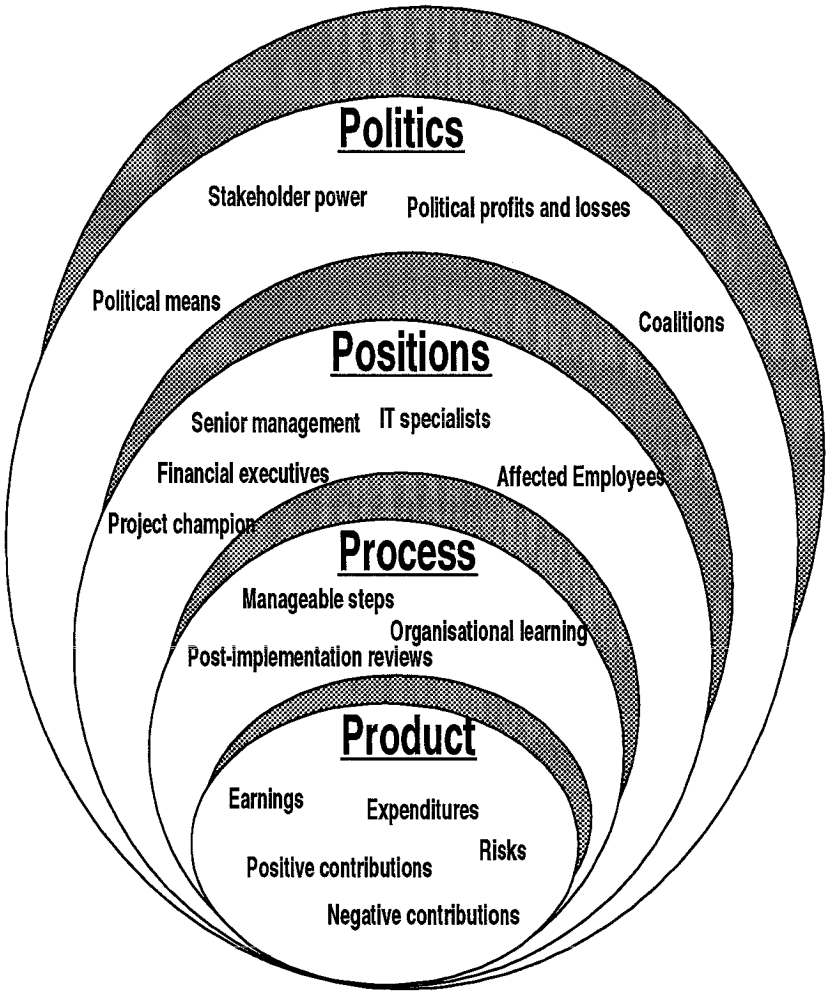

Fig. 2. Framework for investment evaluation.

• *The product of the investment evaluation*

At the heart of the framework lies the product of the investment evaluation, i.e. the set of arguments (evaluation or decision criteria) on the basis of which the decision whether to invest or not is made. Every investment decision is made

against the background and judgement of advantages, disadvantages and risks, that can be both financial and non-financial (see table 3). It is best to make these as explicit and debatable as possible. These arguments also offer a language to communicate the implications of the investment and to increase commitment to the decision made.

The preliminary design of the criteria includes for instance benefits of the indirect infrastructure as a set of capacity related criteria such as efficiency gains, options for IT applications, future degrees of freedom and flexibility and enhancing the quality of the existing capacity. The benefits of direct infrastructure lie in cost savings and displacements, improved effectiveness and organizational transformation onto organizational impacts on culture and job satisfaction which can also prove to be disbenefits. A further distinction is made between two major interdependent decisions:

- The decision whether to (further) invest or not; the 'justification decision'
- The decision on which level on the infrastructure to invest; the 'levelling' decision'.

The levelling decision influences the justification of the infrastructure investments through all aspects given in table 3. Organisational risks may for instance be higher on a higher level of the infrastructure, while the economies of scale and scope also may be higher.

Arguments	**Positive**	**Negative**	**Risks**
Financial	Earnings: - unique - recurring	Expenditures: - internal - external	Cost of capital Hurdle rate
Non-financial	Positive contribution	Negative contribution	Development risks External risks

Tab. 3. The product of the investment evaluation (adapted from [20])

• *The process of the investment evaluation*

The second aspect of the framework shown in Figure 3 refers to the process of the investment evaluation. This process considers the different phases the evaluation goes through; both prior to, and during, project execution. It is recommended to decompose investment decision-making into manageable steps, analogous to well known decision-making models [14, 35]:

- Problem statement;
- Formulation of project goals;
- Evaluation of alternatives;
- Choice of investment alternative;
- Implementation of the chosen solution.

This subdivision of steps is not meant as a linear and rigid procedure, but more as a pattern of thought, with possible loops [26, 43].

Another important recommendation lies in performing post-implementation reviews of the investment decision in order to monitor and control the investment across its life cycle. These reviews provide valuable information on whether the investment actually delivers value for money and to what extent there is still room for improvement. These post-implementation reviews can also be used to establish an investment climate in which organisational learning is encouraged. Many investment decisions are made by 'jumping from one project to the other'. Explicit knowledge of prior investments and their realised value can very much contribute to improved decision-making. Regular reviews of the investment also minimise the phenomenon of 'investment entrapment' [9]; a situation in which ever-greater resource commitments are made because of too much emotional involvement, without sound evaluations of increased investments.

• *The positions of the different evaluation stakeholders*

The third aspect that receives special attention in Figure 3 concerns the positions of the different project-evaluation stakeholders. It is advisable to involve all appropriate people in decision-making with respect to the investment. These include senior management, IT specialists, financial executives and the employees whose work is affected by the investment.

It has been shown (see e.g. [12]) that the likelihood of success of investment projects is considerably improved when there is a 'project champion' involved. This championship refers to the special effort that is made by some involved stakeholder to make the effort a success. This stakeholder does not necessarily have a formal role that implies such an effort. The more powerful this champion's position in the organisation is the better.

• *The politics of the investment evaluation*

The previously discussed aspects of the framework sketched a homogeneous, rational picture of an organisation. This view implies for instance that the different stakeholders in the investment evaluation share the same intentions, goals and priorities (the 'system model', [21]). A more realistic view is that of an organisation in which different stakeholder groups have their own wishes and preferences (the 'coalition model', [21]). Such a view allows for the recognition of conflicting interests and the use of political means to safeguards one's interests. [26, 29] Decision support with respect to the politics of the evaluation lies in what has been called 'stakeholder analysis'. Boonstra [5] suggests the following steps in such an analysis:

1. Listing of stakeholders, their estimated power and impacts of the proposed investment;
2. Assessment of possible 'winners' and 'losers' and their possible (political) 'profits' and 'losses';
3. Establishment of feasible strategies (e.g. financial compensation) to influence the political account of profits and losses.

4.3 Case studies

The discussed model for investment evaluation is model has been used to analyze the evaluation and decision-making process of four cases of infrastructure

investments (see table 4). Case 1 and 2 are decisions about investments in the indirect infrastructure. Case 1 concerns the installation of a 'session manager'; a piece of software for on-line communication in a mainframe environment. Case 2 concerns the investment in the shift from a mainframe architecture to an advanced client-server architecture. Case 3 and 4 are both investments in direct infrastructures to be used by several departments and business units. Case 3 is the investment in a system to report and analyze commercial data, while case 4 concerns the installation of a database with client data, with different data depending on the level of the infrastructure. A preliminary analysis of the case reports shows that:

	Decision made	*Decision under consideration*
Indirect infrastructure	Case 1	Case 2
Direct infrastructure	Case 3	Case 4

Tab. 4. Four case studies of infrastructure investments

- Explicit, more-dimensional decision criteria to evaluate the investment decisions are hardly used, although all decisions are subject to a formal cost-benefit analysis;
- The process and positions of the decision-making process are the most important factors that are used to influence the investment decision;
- Politics is very important in the decision-making process, ensuing from different interests of the organizational stakeholders;
- The two types of decisions (justification and levelling decision) are taken simultaneously.

Group brainstorming session were used to make more explicit the views of IT professionals with respect to the decision criteria that can be used to evaluate infrastructure investments. Data collection took place through brainstorming sessions with five to twenty five IS practitioners working in six case organizations that are business units or subsidiaries of the insurance organization. This shows that:

- With respect to the levelling decision, respondents favour an information infrastructure that lies as much as possible on the business unit level. Candidate investments on a higher level are:
  - A platform for exchanging IT knowledge and sharing expertise
  - Shared information systems for external relations and financial consolidations

- Standards for data exchange and communication.

- With respect to the justification decision, there is a strong preference for financial appraisals. Finance-based methods have a strong historical legitimacy in the case study organisation, originating from its background in financial services. Non-financial evaluation criteria that are considered relevant lie in the realms of:
  - Competitive strategy;
  - Market and client-orientation;
  - Additional quality standards of the resulting information system;

4 Conclusion and future perspectives

This paper argues that the emerging notion of an information infrastructure reflects the increasingly shared and coordinative nature of todays IT investments. Infrastructure investments provide the base foundation of IT provisions that enable subsequent local IT application. The descriptive model of the elements of the information infrastructure offers a language to sketch and communicate the current and future state of this infrastructure. The distinction between a direct and an indirect infrastructure highlights the different roles these infrastructures play in business processes and the different benefits to be gained from them.

Evaluation and management of infrastructure investments involves managing the product, process, positions and politics of decision-making. Decision support along the lines of all four aspects leads to a more 'balanced control' of investment decisions. This balanced control captures both the need to arrive at more sound, rigorous investment appraisal, as well as the organisational context in which this is taking place. Two major, interdependent decisions determine the outcome of the evaluation of infrastructure investments. The levelling decision concerns the level of the infrastructure to invest, while the justification decision involves the whether to (further) invest or not.

The research presented here is for three quarters completed. Several issues can be identified that are the subject of future research work. First, the descriptive model of the information infrastructure will be further developed in case study research. A second and more important research issue is the empirical validation of the guidelines for investment evaluation and management. This should, preferably, be done through a field experiment. The experiment has no formal design yet, and we are open to other suggestions towards gaining empirical evidence of the possible contribution of the research to decision-making practices. A final future research issue concerns the use of the research findings in actual decision-making. Organisational stakeholders in evaluation should be triggered by the research to make their personal, informal assessments and expectations explicit and debate them in a well-structured decision-making process.

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