Galileu
Revista de Economia e Direito
Vol. XIV, n.º 2, 2009/Vol. XV, n.º 1, 2010, pp. 41-54

The evaluation of investments in information technology. Current practices and future guidelines

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Resumo

Este trabalho incide sobre algumas reflexões acerca da avaliação de investimentos na área das tecnologias de informação, nomeadamente em sistemas de informação empresariais. Estes projectos são relevantes por três razões: i) são imprescindíveis para as organizações e para as sociedades; ii) representam cerca de um quarto do presente investimento público e privado anual e iii) a performance das actuais sistemas de avaliação não é fiável dada a evolução financeira do e-comércio e a própria natureza dos investimentos. O sistema de avaliação deixou de ser uma rotina financeira simples evoluindo para abordagens mais complexas, a maioria das quais inclui critérios múltiplos e técnicas de grupo. As nossas reflexões representam uma tentativa de resumir os últimos avanços nesta área e iden-

tificar problemas em aberto que deveriam servir de referência para a investigação futura.

Palavras-chave: avaliação de conhecimentos; sistemas de informação empresariais; investimento público; rotina financeira.

Abstract

This work depicts some reflections about the evaluation of investments in information technologies, namely corporate information systems. These projects are noteworthy because of three reasons: i) they are critical for organizations and societies, ii) they stand for about a fourth of current public and private annual investment, and iii) the performance of current evaluation schemes is doubtful, given the financial evolution of the e-businesses and the very nature of the investments. The evaluation scheme has evolved from a simple, financial based routine towards more complex approaches, most of them comprising multi-criteria and group techniques. Our reflections are an attempt to sum up the state-of-the-art and identify the main open-ended problems that should guide academic research.

Keywords: assessment; business information systems; public investment; financial routine.

The investment portfolio

Project selection implies making decisions about the investments that a company must carry out to maximize shareholders' wealth, given the existing capital restrictions. In practice, this aim is articulated in several financial criteria aimed to both evaluating each

Table 1. The evaluation of individual projects

		Certainty	Risk or uncertainty
Operating foundation	Accountancy--based data	• Non-DCF – Average profit over investment	• Risk is not measured
	Cash flows	• Non-DCF – Value per $ – Pay back – Profitability indexes	• Reducing planning scope • Equivalent certain value
		• DCF – NPV – IRT – Profitability index (Benefit–cost ratio)	• Profit standard deviation • Specific techniques – Interest rate correction – Simulation and sensibility analysis – Fuzzy numbers – Masse's performance indicator
			• Probabilistic models – Hillier's model • Financial models extensions – CAPM – Real options • Multicriteria decision--making

individual option and classifying the alternatives according to its desirability (Table 1).

The adoption of cash flow-based methods reflects the evolution from accountability to modern finance: the desirability of both financial and non-financial investments depends on the value and the temporal structure of the cash flows. This scheme is exceptionally relevant because, aside from revealing the significance of the time scope, it enables using a wide range of mathematical and statistical techniques to measure performance and risk.

More recent advances extended the basic cash flow-based scheme by introducing more complex and comprehensive measures of value

and risk, from fuzzy numbers to extensions of hard financial models; CAPM has rendered a new outlook of risk with the concept of volatility, while OPM[1] bestowed the basis to evaluate *real options*. Remarkably, some models are able to merge hard financial indicators and qualitative data, e.g. beliefs, viewpoints, or group judgements.

The election of the criterion to be applied depends on the decision environment and on the nature of the projects themselves. For example, equipment is usually examined according to hard financial criteria, namely efficiency or productivity, while R&D projects are evaluated considering some wide, *soft* criteria such as their potential impact over learning or future competitiveness. Moreover, a single decision-maker usually carries out operational decisions, while R&D and some other strategic concerns are typically scrutinized by groups.

The evaluation of IT investments

First IT applications were evaluated according to efficiency and productivity criteria because their economic pattern was supposed to be akin to that of machinery and other equipment. Productivity improvements were initially verified but, as organizations developed corporate information systems, the assumed link vanished: unlike automation-oriented applications, the new infrastructures were aimed to support decision-making and the strategic process by supplying models and relevant information. This caused a radical break in the evaluation process: managers should consider not only efficiency, but also the degree in which the project matched business objectives.

The evaluation scheme has evolved, very slowly, throughout the last two decades to embrace a wider and more comprehensive view of the business value of the IT investments. This framework is inten-

[1] CAPM, Capital Assets Pricing Model; OPM, Options Pricing Model.

ded to deliver a global, inclusive view of the business value of the investments by integrating several risk and value attributes.

Current evaluation practices

Most of the companies currently evaluate their IT investments according to financial criteria, namely net present value (NPV), internal rate of return (IROT), and payback; these indicators are systematically used by 75% of the companies, and are applied to up to a half of the IT-based investments[2]; managers rely on IROT to identify and discard unfeasible options, and to classify the remaining projects.

The degree in which the project supports business objectives is an essential prerequisite, however management ant technical considerations are usually downgraded: more than a half of the companies give a pre-eminent weight to financial ratios and cost-benefit analysis[3]. Thus, *qualitative* features as decision support, quality, or job enhancement seem to be put out of place by more tangible, concrete definite attributes.

The final decision is, in most cases, made by an executive board; therefore the lack of dialogue in the early stages frequently conveys both to the final evaluation of feasibility and to the implementation outline. This may be intended to give the decision a high hierarchical status, to enhance the integration of IT investments, or to control the resources allocation, or even be a manifestation of devolution. However, the displacement of end-users and local managers entail the loss of the business operations perspective and, depending on the decision strategy followed by the executive board, a systematic bias towards eye-catching, gleaming projects to the detriment of alternatives that are not expected to enhance executives' reputation.

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[2] Bacon (1994).

[3] Willcocks and Lester (1994).

What do we know?

Let us begin our discussion with a brief case. In the first nineties, the European telecoms entered into a fierce competition to acquire home and abroad UMTS licenses, even though the new services were not expected to be fully developed until the mid nineties. The introduction of third-generation mobiles was delayed again and again until the last years of the decade, and UMTS is now evolving at a very low pace because some unexpected technical difficulties – poor image quality, slow downloads, security issues – and the weakness of the demand.

UMTS auctions have been pointed out as the paramount instigator of the financial distress suffered by some telecoms, but companies claim that the financial effort will pay in the future. They argue that, regardless its payback, abstaining from the auctions would imply a clear competitive risk because UMTS is the link between the classic phone business and the emergent Internet and multimedia businesses

Telecom's attitude is revealing: it is not only the *hard* financial scheme what defines the value and the risk of an IT-based project; companies do also consider some *soft*, qualitative features such as the technical issues entailed by the project, the perceived desirability, and its competitive profile, both in value and risk terms. Telecoms adopted UMTS projects because, although short-term profitability was doubtful, they allowed companies to prevent some long-term competitive risks and encouraged learning and knowledge creation.

In fact, the classic justification of IT investments has been under suspect since the first nineties, when researchers failed to prove the expected relationship between productivity and IT investment. Several arguments have been proposed to explain what Solow defined as the *productivity paradox*[4]. Some of them claim the impact of

[4] Brynjolfsson (1993), and Brynjolffson and Hitt (1998).

the economic crisis over the financial performance, while a relevant part of the researchers maintain that standard financial ratios do not express a complete view of the desirability of IT-based investments. It has also been proposed that the match among strategy, structure, and the new environment is still imperfect, thus damaging corporate performance[5]; if so, the financial evaluation might be biased due to the transition inefficiencies.

A different line of reasoning is the *mismeasurement hypothesis*: our efforts to prove the contribution of IT have almost failed because the utilities derived from these investments are not present in the current definitions of productivity and profitability – e.g. intangible utilities, hidden costs, and time lags –. This is a relevant argument: a project is desirable if it increases shareholder's wealth, and let us assume that we measure this contribution according to its net present value (NPV). What if this link is biased by intangible factors not addressed by NPV?

Companies do implement e-business solutions but, if they were examined in hard financial terms, these projects would be systematically discarded because profitability expectations are unclear and the payback is open-ended. This instance is somewhat akin to the UMTS case: although financial uncertainty, mobile projects were carried out because they were supposed to drive some long-term intangible utilities, namely learning and avoiding competition.

We will go back to the mismeasurement hypothesis in . Previously, let us examine a second, implicit, relevant assumption: most of the classic performance indicators depend on the nominal value of the investment. However, IT are *facilitating* resources[6], hence the real impact over performance depends not on the investment itself, but on the ability to successfully address business needs or exploit emerging opportunities.

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[5] Freeman (1991).

[6] Earl (1989).

A classical example of facilitating technology is electricity; companies did not attained productivity improvements until they intentionally *adapted* the productive processes to the very nature of this new energy[7]; thus, the critical issue was not investing in electric equipment itself, but properly using electrical energy to enhance business performance. By the mid nineties Volvo invested 100.000$ in developing and marketing a web site to connect with potential clients and collect demographic data; the system failed almost immediately and had to be redesigned because it did not support sales objectives. One quite different case is that of Barrabes.com, a successful site where users can find most of the facilities required to practise almost any winter sport. These examples suggest that *it is management– creativity, dynamism, assertiveness – what makes the difference.*

Open-Ended issues and future Guidelines

The pre-eminence of financial criteria in the evaluation of IT-based investments is a natural consequence of the search for efficiency; the introduction of business alignment criteria is also relevant because it allows the company to ensure that the resources are allocated to desirable projects *even* if they are not profitable in the short term. This is clearly coherent with the aim of enhancing shareholders' wealth because a short-term bias would result in a loss of competitiveness and, thus, in a reduced net present value of the future profits: shareholders will accept the allocation, and the resulting cut in their current cash flows, if the investment is supposed to yield a *satisfactory* return in the long term.

This outline entails several problems: first, we are currently unable to prove a causal, systematic relationship between the implementation of most IT-based projects and the evolution of both cash flows

[7] David (1989).

and corporate financial indicators; then it is doubtful that we can rely on these ratios to make an *all or nothing* decision about feasibility. Second, most of IT investments do not have a clear, direct and discernible effect on corporate cash flows, but on *performance* itself. Third, nothing has been said about foreseeing and evaluating the several risks involved in new technologies, apart from the classical standard deviation of NPV. Fourth, some relevant outcomes, charges and risks associated to IT investments are not quantifiable, in the classic sense of this word – IT are, in fact, *facilitators* and comprise a clear strategic dimension –; this fuzziness break some core hypotheses of financial analysis. Finally, even if we were able to effectively adapt financial ratios, how to rationally combine these quantitative outcomes with the more qualitative judgements about business alignment, decision support or edification of *invisible assets*?

At this moment there is not a clear, complete answer to these questions; yet we can advance some desirable features of the evaluation scheme.

Contribution as the general feasibility criterion

Regardless its external appearance, the underlying aim of any project selection methodology is to analyze the degree in which each project deals with business goals, threats and risks; in more wide, philosophical terms, evaluation is aimed to verify the alignment of each alternative with shareholders objectives, namely their wealth.

Managers usually feel themselves impelled to analyze feasibility in financial terms because ratios are supposed to be objective, comparable, and reliable; but financial appraisal is not an objective itself, but an instrument aimed to explore the contribution to that more comprehensive objective of wealth. The potential risks of this scheme have been have been implicitly assumed by managers, who are trying to evolve the classic evaluation frame towards a more comprehensive

scheme where projects are ranked according to several business criteria expressing their contribution to business objectives.

This does not mean looking down on the financial evaluation, but opening the perspective to a more wide business viewpoint and embracing intangible issues that previously had been displaced because they are hard to quantify, e.g. acquiring experience, learning, or building invisible assets.

Intangible value factors, hidden costs and emergent risks

One relevant question, not always properly addressed, is the management of project costs. Managers usually concentrate in explicit, tangible charges (e.g. hardware, installation, maintenance), but implementing IT projects also entails undertaking some implicit charges (e.g. personnel continuous training, security) and assuming the more wider organizational costs caused by the adaptation of corporate structure and business tasks. Besides that, accepting an IT project implies a long-term compromise because projects usually entail follow-up charges.

The estimation of these charges – and of the risks themselves – is complex because, apart from their fuzziness, IT projects are usually singular. An accurate forecast typically requires some historical basis over which mathematical and statistical models are applied; but this data are not available because most IT investments are the first of their category, sometimes because they are intrinsically singular, and in other cases because companies are still developing the IT infrastructure for the first time.

The scope is now shifting from controlling the IS costs towards *managing* IS as a business support infrastructure; hence, one relevant variable has been added to the equation: the *business value* of an IT investment. Managers must not concentrate on expenses, but on the relation among the *investment* required to carry on a project

and its *value* in terms of decision support, and coverage of business threats and opportunities.

How should we evaluate this relationship? As we have seen, the nominal value of the investment is not a reliable measure because of the versatility of IT. Some companies simply try to catch up the industry average investment, but these comparisons may be dangerous: information systems are idiosyncratic structures, thus they must be developed according to the individual requirements of the company. *The emergent economic environment does not call for imitation behaviours, but for new mind-sets based on innovation.*

Multicriteria decision making

One underlying statement is the adoption of a multicriteria decision approach; an information system is a multi-faceted structure that can be viewed from multiple perspectives: financial, technical, human, and so on. Any single, naïve evaluation approach would give a partial view of the desirability of the investment, hence is necessary to move towards more comprehensive frames and, at the same time, keep a moderate degree of complexity.

This situation does not have any optimal solution because accuracy and easy-of-use are conflicting objectives; apart from the problematic issue of managing the qualitative factors, managers find it difficult to get an integrated, global measure of desirability. Hence, a critical issue is to design a methodology able to manage several qualitative attributes as well as quantitative traditional financial ratios.

Opinion modelling

Some of the key criteria currently considered by managers consist of subjective judgements; for example, the support to decision -making or the ease-of-use are in essence qualitative viewpoints.

If decision-making is a rational process, these preferences must be analyzed and integrated to build a comparable outlook of the desirability of each project.

Opinion modelling is the generic term used to design a heterogeneous group of techniques aimed to extract, from qualitative statements, quantitative inferences that can be afterwards processed by numerical methods. Some well-known techniques able to model judgements are Saaty's *Analytic Hierarchy Process* (AHP)[8], Electre and Promethee. AHP is widely used to support group decision and to evaluate qualitative factors expressed by means of individual judgements; it is able to rationally rank the available alternatives according to the preferences implicitly expressed by the decision-makers, even though it does not guarantee their feasibility.

Group decision

Most of the major IT investments are evaluated and selected by collective decision-makers; groups are supposed to enhance the decision analysis by combining different views of the problem, integrating information, building a consensus, and facilitating the acceptance of the final election. Cooperation increases the satisfaction of the members of the organization, because they feel themselves encouraged to express ideas and judgements.

From our perspective, the most relevant concern is the use of group decision to combine the different perspectives underlying an IT investment: finance, end-users, managers, technicians, and even representatives of external interests, for instance clients or Government agencies –. In fact, some massive projects, such as the development of Electronic Data Interchange (EDI) systems, require a consensus among different companies and institutions.

[8] Saaty (1980), for a extensive description of the methodology.

Standardization vs. multiple, idiosyncratic evaluation approaches

A final, but not minor, question is the design of the general evaluation frame. More specifically, the company must make an election between using a standardized evaluation protocol or applying selective criteria, in line with the very nature of each investment category. For example, we might agree in applying efficiency and cost-based criteria to automation investments, and more *eclectic* business criteria to decision-support or R&D projects.

This latter approach is quite familiar for managers, who usually make out several categories of investments: automation projects, innovation projects, customer-support investments, decision-oriented projects, and so on. However, information systems are nowadays corporate-wide structures, thus transactional and decision-oriented services are closely related; as a result, we cannot make a real distinction among transactional and decision-oriented projects. Moreover, some originally transactional investments evolved towards decision support and have even provided companies with competitive advantage, which is supposed to be a DSS feature. A classical example is the transactions-oriented system SABRE; regardless the ethical reflections brought to mind by the use of competitor's operations data, the system rendered a systematic contribution to AA's competitiveness and allowed the introduction of new business strategies, such as *yield management*. Thus, a productivity-based prior evaluation would be biased and partial.

The evaluation protocol must guarantee a *consistent* allocation of resources, where consistency implies following a clear, unambiguous strategic line in the edification of the information system, avoiding opportunistic investments, and following the path of business requests. This frame should also ensure technical compatibility throughout the company, and endow the decision-makers with feedback information to allow continuous learning. We believe that these aims can be addressed by a strategy of cooperation, based on group work.