Challenges in IS Evolution Benefit Assessment

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Abstract

In this paper, the challenges of information system evolution benefit assessment are reviewed. Classical investment criteria and their advantages and disadvantages with respect to evolution options assessment are studied. The following potential challenges in evolution investment decision making were identified: selecting a proper analysis method, acquisition of suitable metrics and follow-up data, and valuation of the results. A preliminary framework, ISEBA, was developed to address these challenges.

1. Introduction

Maintenance and system evolution activities have a significant role in the information system (IS) life cycle. 80% of the total IT expenses are caused by the maintenance activities of an existing information system [16]. According to Lehman's first law, maintenance is necessary, because software needs to be continuously improved or it will get out of date and cannot respond to the requirements of its environment [15]. Despite importance of system evolution investments, there is a gap between the IT related costs and company profitability [21]. Brynjolfssen [8] described this as a productivity paradox: information technology utilization has increased since the 70's but simultaneously productivity has slowed down.

The work effort of maintenance is generally proportional to the life time of a system. Therefore, it is more dominant in old legacy information systems (LIS) [6]. Besides being old, LIS is typically large at size and contains vital information for the user organization, uses out-of-date technology, and is laborious to maintain [2]. The inability to modify software rapidly may cause difficulties in exploiting new market opportunities [3]. There are three ways [2] [20, p. 8-10] of dealing with a hard-to-maintain system: 1) maintaining, the system as it is, 2) developing or purchasing a new system to replace it, or 3) radically improve, i.e. modernize, the legacy system. A careful consideration of

operational environment and organizational context is a prerequisite for a successful IS migration [4].

IT investments can be roughly classified in two categories, acquisition projects, and development projects [19]. Acquisition project includes purchasing hardware or off-the-self software. Development investment refers to a project that aims at developing new or modernizing an old system. In this paper, the focus is on the latter.

This is a work-in-progress paper that summarizes the preliminary work on IS evolution benefit assessment within an industry co-operation project called ELTIS (Extending the Lifetime of Information Systems) during 2003-2005. The project is carried out in the Information Technology Research Institute (ITRI), University of Jyväskylä, Finland. It focuses on extending the lifetime of IS in an economically viable manner.

2. Investment criteria

Dehning and Richardson [10] conducted a literature review on studies covering the impacts of IT on firms' performance in 1997-2001. In most of these studies, IT investments had been evaluated with the means of direct performance or accounting measures. That is where the business owner, by tradition, is expecting to see the implications of investments. In case of IS evolution investments, however, the benefits are not necessarily reflected on the firm's performance or accounting figures. The financial investment criteria can only detect tangible benefits while ignoring the intangibles. In the past, several benefit assessment methods have been developed in order to address this problem [13]. In this paper, the focus is on the so called classical financial investment methods. On the basis of a literature review, the advantages and disadvantages of eight financial investment methods are presented and their suitability on IS evolution assessment is evaluated.

Classical investment criteria can be divided in three categories: 1) discounted cash flow criteria, 2) payback criteria, and 3) accounting criterion. Discounted cash flow criteria include *net present value* (NPV), *internal rate of return* (IRR), and *profitability index*. Payback criteria consist of *payback period* and *discounted payback* period. Accounting criterion consists of average accounting return (AAR). [18, p. 256]. Other investment criteria include *return on investment* (ROI) method and *real options* method [9, p. 139]. Investment criteria, their advantages and disadvantages are described in Table 1.

In general, discounted cash flow criteria are considered the most preferred option when evaluating investment proposals [18, p. 256]. NPV is in most cases the recommended approach [18, p. 256]. They can only result in *accounting rate of return,* not the *true* rate of return. In order to acquire a good understanding of the profitability of an IT investment, Curley [9, p. 73] suggests using at least three financial metrics. Additionally, calculations should be conducted before and after the project [9, p. 76]. Typically, the financial analysis of acquisition projects has been conducted with NPV or *discount cash flow* (DCF) analysis [11]

Table 1. Investment criteria.

Criteria and definition	Advantages	Disadvantages
NPV The difference between an investment's market value and costs [18, p. 233].	+ Includes time value of money [9, p. 73] + No serious flaws [18, p. 256]	- Unsuitable for analyzing acquisitions because of short-term and user-oriented focus [11] - Unable to deal with uncertainty [19]
IRR The discount rate that makes the NPV of an investment zero [18, p. 245].	+ Includes time value of money [9, p. 73] + Results are easy to communicate and understand [18, p. 253]	- May lead to incorrect decisions if project cash flows are unpredictable, investment options are mutually exclusive, i.e. taking one investment prevents another [18, p. 253] or level of uncertainty is high [19]
Profitability Index The present value of an investment's future cash flows divided by its initial cost [18, p. 253]	+ Results are easy to communicate and understand [18, p. 253-254] + Useful if investment funds are scarce [18, p. 253-254]	- May give misleading results when investments options are mutually exclusive [18, p. 254]
Payback period A time period from the moment when an investment is made to the moment when the cash flow from the investment equals to the original investment cost [18, p. 240].	+ Simple and easy to understand [18, p. 240] + Adjusts for uncertainty of later cash flows [18, p. 240]	- Requires an arbitrary cut-off point [18, p. 240] - Ignores time value of money and cash lows beyond cut-off date [18, p. 240] - Biased against long-term or new projects, and liquidity [18, p. 240]
Discounted payback period The length of time required for an investment's discount- ed cash flows to equal its initial cost [18, p. 240]	+ Includes time value of money [18, p. 242]	- Ignores cash flows beyond cut-off date [18, p. 256] - Biased towards liquidity [18, p. 242]
AAR An investment's average net income divided by its average book value [18, p. 243]	+ Easy to calculate [18, p. 245] + Needed information is often available [18, p. 245]	- Ignores the opportunity cost of money [7] and time value of money [18, p. 245] - Does not compare to real market returns [7]
ROI The ratio of net benefits plus the original investment divided by the initial investment [9, p. 70].	+ One of the most significant calculation methods for evaluating managerial performance [5, p. 207] + Simple and clear [9, p. 70]	- Ignores the scale of the investment and timing of cash flows [5, p. 207] - Not useful for planning [5, p. 207] - Insufficient if used alone [9, p. 72-73]
Real options An approach used to evaluate alternative management strategies using traditional option pricing theory applied to real assets or projects [1].	+ Is able to deal with uncertainty [19] + Provides managerial flexibility: decisions about the investment can be changed as new information becomes available [9, p. 146] [19] + Includes timing and risk [9, p. 142]	

but also options pricing model has been applied [19]. ROI has been used to evaluate the benefits of software reuse [16]. However, there are no reports on the use of these methods in evolution strategy decision making.

3. Challenges

The main challenge in evaluating IT investments is that the benefits cannot always be expressed in financial terms [17]. If the anticipated benefits are tangible and can be measured in terms of money, then financial investment criteria can be applied. However, as presented above, classical investment criteria are not uniformly suitable for every situation. If a method is selected carelessly, the results may recommend a refusal of a potential investment proposal simply because the selected method ignores a relevant factor [18]. Respectively, an unprofitable investment may seem potential if improper analysis methods are used. Therefore, the first challenge is the selection of a suitable benefit assessment method. In order to conduct a benefit assessment for investment options, a company has to gather IT-related data concerning its own activities to support management decision making [21]. This presumes the existence of a proper metrics program and follow-up. A related risk is that selected metrics do not capture the value of IT [21]. Metrics and follow-up data are to be conversed in a commensurable format before a cost-benefit analysis can be carried out [12]. Data conversion may be tricky, if benefits appear as soft issues, which are difficult to express in terms of money. In order to avoid confusion with data conversion, the expected benefits should be identified before data acquisition.

4. Framework for IS benefit assessment

ISEBA (Information System Evolution Benefit Assessment) is a preliminary framework for providing assistance in selecting a suitable benefit evaluation method for investment situation at hand. It is based on empirical research consisting of interview study of industrial decision making and industrial co-operation projects, and examination of the challenges of benefit estimation for IS evolution options. It obliges instructions about the metrics and follow-up data that the selected formula requires as input. ISEBA consists of eight phases: 1) identifying the characteristics of investment situation, 2) identifying investment type, 3) defining investment assessment emphasis, 4) estimating organizational capabilities and comparing them to the requirements and labour intensity of potential benefit estimation methods, 5) selecting suitable method(s) and identifying related risks, 6) gathering required follow-up and metrics data for benefit assessment, 7) performing benefit assessment for investment proposals, and 8) interpreting and valuating results.

The implementation of ISEBA follows the form of a decision-tree. Phases 1 to 4 rule out the improper methods and provide a list of potentially suitable methods. In Phase 2, the investment type (acquisition or development project) of investment proposals is defined. This defines the post-investment measurement timing. The assessment emphasis in Phase 3 refers to financial or non-monetary benefits. It can be decided that either financial or intangible benefits or both are assessed depending on the investment characteristics. In phase 4, it is important to evaluate the resources and skills the organisation is able to allocate for evaluation. The final selection of suitable methods is based on the comparison on of the potentially suitable methods and organisation's resources, skills and available data (phase 5). ISEBA supports method selection by providing a description of required input data of each method. In Phase 6, data acquisition is carried out. The execution of benefit assessment takes place in phase 7. Finally, in phase 8 the results are examined and valuated in compliance with organization's strategies. If more than one investment proposal is to be evaluated, it is defined in Phase 1. A more detailed description of ISEBA is given in [14].

5. Summary

On the basis of the literature survey, it can be concluded, that the overall benefits of software evolution have not been studied comprehensively so far. The comparison of the characteristics of investment criteria shows that the best suited criteria for IS evolution evaluation are discounted cash flow criteria and ROI. Accounting criteria tend to be too general while real options method is overly specific and demanding to apply. Potential challenges related to evolution investment assessment are selecting a proper analysis method, collecting suitable metrics data, and valuation of the results. Inspired by these challenges ISEBA framework was created. In the future, ISEBA should be further developed and validated empirically. Both activities are currently promoted in ELTIS. There is one completed and two on-going software industry related projects, which incorporate evolution benefit assessment.

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