# Information systems evaluation and the information systems development process

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**Abstract**

In this paper, we consider the synergy between two areas of information system (IS) literature: that concerned with the evaluation of IS and that concerned with explaining the phenomenon of IS failure. On the basis of an analysis of both areas, a model is presented which attempts to integrate IS evaluation into the life cycle of IS development. The model links the issue of failure assessment with the evaluation process and constitutes a strategy for stimulating organisational learning in relation to IS development. The paper concludes with a description of our attempts to validate aspects of the model and plans for further empirical work in this area.

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## 1. Introduction

According to Willcocks (1992), evaluation may be defined as “establishing by quantitative and/or qualitative means the worth of information technology (IT) to the organisation”. The notion of worth is inherently associated with definitions of success or failure. In terms of information systems (IS) we can distinguish between the worth of the product (the IS), and the worth of the process (the activities involved in producing the IS). In practice, it is clearly difficult to separate the two. The worth of the IS development process is normally evaluated in terms of an assessment of some features of the worth of the product. Evaluation is critical to process organizational learning in terms of IS/IT in that it is only through effective evaluation that an organisation may develop an effective knowledge based on which successful development practice can be achieved.

Current evidence suggests that the worth of IS (both as a product and a process) is open to question (Brynjolfson, 1993) that evaluation is not treated seriously by organisations, and consequently that organisational learning in terms of IS/IT is limited. For instance, Willcocks (1992) finds a fall-off in evaluation at the project stages following feasibility, little attempt to link evaluation across the life cycle of systems and a fragmented approach to learning from the evaluation experience. He recommends an integrative approach to evaluation across the life cycle. However, there is little in the way of a coherent set of recommendations as to how this integration is to be achieved.

The aims of the paper are as follows. First, to review the literature on IS evaluation, particularly in the light of lessons learned from the areas of IS failure and organizational learning. Secondly, to present a preliminary model that attempts to integrate approaches to IS evaluation into the life cycle of the development process, incorporate the ideas of failure assessment into the evaluation process, and build a number of organizational feedback loops into the model with the aim of promoting organizational learning. Finally, current experience and plans for validating elements of this model in further empirical work are discussed.

## 2. Existing literature

In this section, we give a brief review of lessons learned from two areas of IS literature: that concerned with the evaluation of IS and that concerned with explaining the phenomenon of IS failure.

### 2.1 Lessons learned from the literature on IS evaluation

According to Willcocks (1996), contemporary IS literature appears to be focused upon issues of evaluating the *utility* of an IS (that is to say, does the information deliver key business benefit for the organisation?). The literature tends to assume the evaluation of two other dimensions against which an IS may be evaluated, namely functionality (does the IS do what is required?) and usability (is the IS useable by its intended population?). Assessing the degree to which a system is functionally complete and consistent is a classic concern of the systems development community. Assessing the usability of systems has become increasingly important with the continuing progress and use of graphical user interfaces and multimedia interfaces.

Assessing the utility of IS is something which most organisations conduct at the pre-implementation stage of a project, but seldom subsequently. Pre-implementation evaluation is becoming increasingly important due to greater pressure being placed on the IS function to more closely account in financial terms for its activities. Hence, both practice of IS evaluation and research conducted in this area focuses primarily on strategic evaluation (Ballantine and Stray, 1998).

The extant literature provides little practical advice on how evaluation should be integrated into the life cycle of IS development. This literature appears to offer a less advice, for instance, as to how proposed practices may be integrated with traditional issues of project management. We believe that the effective integration of evaluation with life cycle issues is likely to lead to a greater adoption of evaluation approaches amongst organisations.

Although rarely explicitly stated as such, evaluation of both IS and the processes by which they are developed are inherently associated with the issues of IS success and failure (Lyytinen and Hirschheim, 1987). However, there appears to be a lack of material which attempts to integrate lessons from the literature on the issue of IS failure with lessons from the material on IS evaluation.

The limited evidence that exists suggests that organisations appear to engage little with the issue of IS evaluation, and appear to learn little from IS successes and failures (Owens and Davies, 1999). What learning does occur appears to be in the form that Argyris and Schon (1978) refer to as single-loop learning. In single-loop learning, individuals respond to error by modifying strategies and assumptions within constant organizational norms. Such learning is directed at increasing organizational effectiveness. In double-loop learning, response to detected error takes the form of a joint inquiry into the organizational norms themselves, the purpose being to resolve the inconsistency between the existing norms and make a new set of norms realisable (Figure 1). There currently appears to be a less evidence of organisations engaging in double-loop learning as far as IS development practice is concerned.

### 2.2 Lessons learned from the literature on IS failure

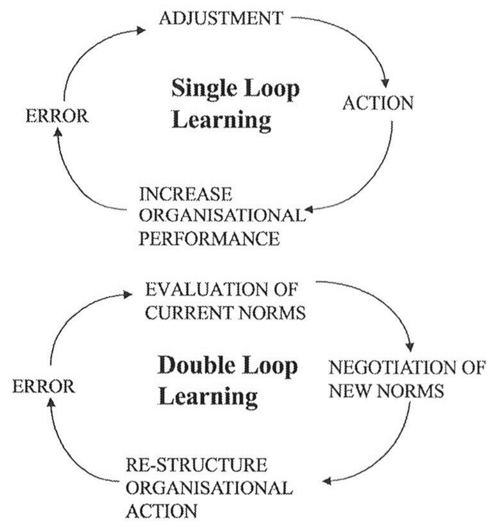
IS failure and success (DeLone and McLean, 1995) are clearly opposite sides of the same coin. Having insufficient space available to discuss the material on IS success here, we concentrate on the issue of IS failure.

A survey conducted by the US Government's Accounting Agency (1985) in 1979 (ACM) found that less than 3 per cent of the software that the US government had paid for was actually used as delivered. More than half of the software was never used at all. In an international survey conducted by Coopers and Lybrand (1996), 60 per cent of organisations internationally and 67 per cent of organisations within the UK had suffered at least one systems project that had failed to deliver planned business benefits or had experienced cost and time overruns.

It is important to understand that failure is not an objective concept. The definition of failure depends on the position and perspective of the definer – it is an intersubjective concept. Hence, Lyytinen and Hirschheim's (1987) concept of expectation failure is critical. Expectation failure refers to the inability of an IS to meet a specific stakeholder group's expectations.

As a consequence of the definition of expectation failure, the identification of stakeholders and their likely impact on the trajectory of an IS project is extremely important.

**Figure 1** Single and double loop learning


ADJUSTMENT
Single Loop Learning
ERROR
ACTION
INCREASE ORGANISATIONAL PERFORMANCE
EVALUATION OF CURRENT NORMS
Double Loop Learning
ERROR
NEGOTIATION OF NEW NORMS
RE-STRUCTURE ORGANISATIONAL ACTION

IS failures signify a gap between some existing situation and a desired situation for members of a particular stakeholder group. Stakeholders are any group of people who share a pool of values that define what the desirable features of an IS are, and how they should be obtained.

The trajectory of a project is defined as the historical shaping of an IS both before and after delivery. Frequently, the shape of an IS is determined by the power play between different stakeholder groups (Ballantine and Stray, 1998; Keen, 1981). It should be recognised that an IS, and an IS project, are a significant power-resource in organisations. Failure can occur prior to the delivery of the IS. This is the notion of project abandonment or what Lyytinen and Hirschheim (1987) refer to as development failure. Sauer's (1993) conception of termination failure corresponds to the idea of total abandonment of a project. However, projects may be substantially or partially abandoned. In this case, the goals of the IS may be reduced or reconfigured. Failure may also occur after an IS has been delivered to its user community. This is the idea of use failure (Lyytinen, 1988). Use failure normally occurs because the end-user stakeholders feel that the IS does not match their expectations (Kling and Iacono, 1984).

IS projects are frequently the subject of escalation in decision-making. Drummond (1994) defines escalation as "the predicament where decision-makers find themselves trapped in a losing course of action as a result of previous decisions. Costs are incurred; there is an opportunity to withdraw or persist; and the consequences of withdrawal or persistence are uncertain. Typically, the response to such dilemmas is irrational persistence". The important point about escalation is that support for an IS project can continue even in the face of major system flaws. Major stakeholders in a project may be reluctant to withdraw support due to heavy investment in personnel and other resources devoted to a project (Keil, 1995; Newman and Sabherwal, 1996).

## 3. A model of IS evaluation

A model of IS evaluation closely aligned to the life cycle of IS development is shown in Figure 2. This model is based on, but much extended from that proposed by Ewusi-Mensah and Przansnyski (1995). It constitutes a preliminary attempt to utilise the lessons from both literature on IS failure and IS evaluation and attempts to specify necessary organizational processes which embody the importance of evaluation to processes of organizational learning and the avoidance of IS failure.

### 3.1 Importance of the model

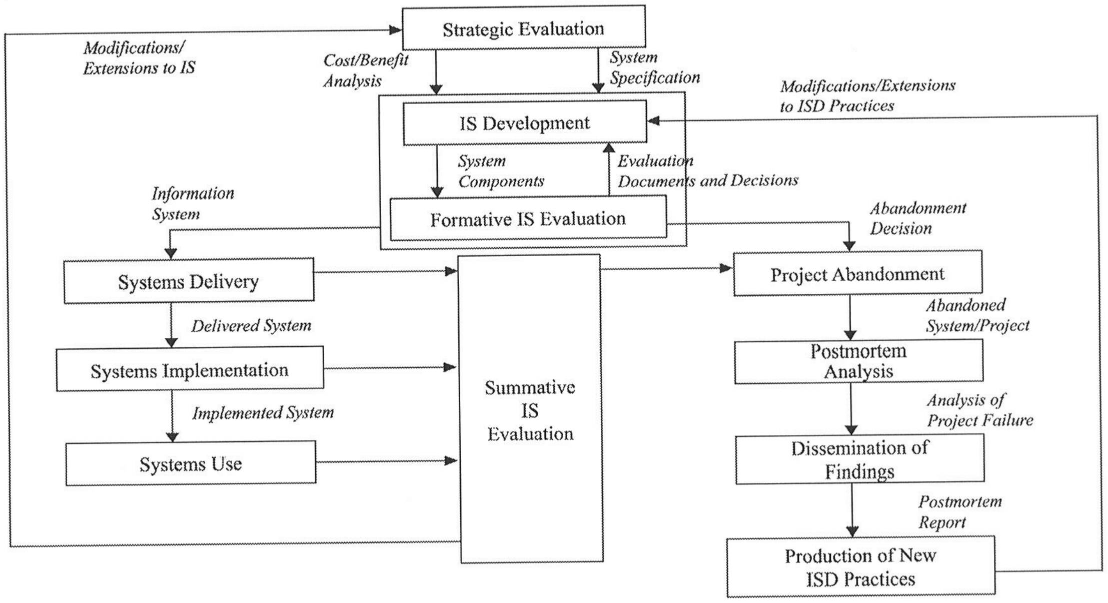
This model is important for a number of reasons. It incorporates processes of evaluation more closely into the development activities of organisations. It does this by distinguishing between a number of distinct types of evaluation and defining their rightful place within the development life cycle. The model builds upon the lessons learned from the extensive literature on IS failure, particularly the fact that the participation of representatives of stakeholder groups (including end-users) is critical to all processes of evaluation. Stakeholders need to be the explicit evaluators of IS products. It emphasises a number of feedback loops that encourage elements of organizational learning and it acknowledges the fact that development failure is in a commonplace. Failure is not just about total abandonment of projects. It is important for organisations to evaluate reasons for the substantial or partial abandonment of development projects.

### 3.2 Types of evaluation

The model makes a distinction between four types of IS evaluation activity, primarily in terms of when they take place in a standard linear model of the IS life cycle. First, strategic evaluation, which is sometimes referred to as pre-implementation evaluation. This type of evaluation primarily involves assessing or appraising an IS/IT investment in terms of its potential for delivering benefits against estimated costs. To do this some preliminary idea of the functionality and likely usability of the system needs to be established. Second, formative evaluation involves assessing the shape of an IS whilst in the development process itself. Formative evaluation may be used to make crucial changes to the design of an IS or to make critical decisions concerning the degree of project abandonment. Although formative evaluation will primarily review issues of functionality, this assessment will continuously be shaped by notions of a systems usability and utility formulated in the changing context of some organisation.

The third type of evaluation identified occurs after an IS has been implemented. For this reason it is sometimes referred to as post-implementation evaluation. Traditional approaches to summative evaluation involve signing off some system against its specification. More recently, there has emerged an emphasis on usability testing. Ideally, summative evaluation involves returning to the costs and benefits established in strategic evaluation after a period of use of the IS.

**Figure 2** IS evaluation and organisational learning



Summative evaluation may also produce ideas for new systems and/or components. Finally, we identify post mortem analysis. This is a variant of summative evaluation particularly directed at organisations learning from their partially or totally abandoned projects.

## 4. Discussion

The model (Figure 2) is an attempt to build clear formulations of distinct forms of evaluation appropriate to various parts of the IS development life cycle. In particular we distinguish between the processes of strategic, formative and summative evaluations. Strategic evaluation is a necessary pre-development activity, formative evaluation is a necessary part of the development activity itself and summative evaluation a necessary post-development activity. We also include in the model a necessary evaluation activity which, following Ewusi-Mensah, we have chosen to call here, post-mortem analysis, which is a variant of summative evaluation. This type of evaluation is essential in developing an understanding of the reasons for full or partial abandonment of IS projects.

### 4.1 Strategic evaluation

Most organisations conduct some form of strategic evaluation of IS projects (Ballantine and Stray, 1998). Strategic evaluation may be conducted as part of strategic planning process, more usually as part of some project selection or feasibility study. Strategic evaluation is designed primarily to evaluate aspects of utility and cannot be done without some early notions of functionality.

Strategic evaluation is an activity that attempts to establish the balance of predicted costs and benefits in terms of an intended IS project. We have called it strategic evaluation because of its ideal role in determining elements of both long-term and short-term IS strategy. Strategic evaluation is normally used to initiate a go/no-go decision in terms of a given development project. It may also be used to prioritise a number of IS investments. The most popular techniques applied in this process are *return on investment* and *payback period*. Such techniques are effective ways of evaluating tangible costs against tangible benefits. One of the most popular strategic evaluation frameworks that include facilities for an assessment of intangible costs and benefits is *Information Economics* (Parker and Benson, 1988).

### 4.2 Formative evaluation

Formative evaluation should be an inherent part of the project management process in the sense that development and evaluation should be parallel activities. Development projects should be continually assessed against objectives and careful attention should be paid to this activity to avoid project escalation. Project escalation is defined as the continued commitment to an IS project in the face of continual negative information from formative evaluation exercises. Major stakeholders in an IS project may be reluctant to withdraw support because of heavy investment in personnel and other resources devoted to a project.

Formative evaluation may focus on issues of process or that of the product. Traditional approaches to project management tend to emphasise the formative evaluation of process elements. The emphasis is in decomposing a project into a series of tasks or activities that are evaluated against performance at regular intervals. Alternative approaches to formative evaluation, popular in such development methods such as rapid applications development (RAD), take a product-based focus. Here, the emphasis is in defining a series of project deliverables and negotiating the so-called time-boxes (fixed deadlines) for the delivery of these system products (Stapleton, 1997).

### 4.3 Post-mortem analysis

At some point in the development process a decision may be made to either wholly or partially abandon a project (what Lyytinen and Hirschheim call development failure).

In terms of development failure (project abandonment), Ewusi-Mensah and Przasnyski (1995) distinguish between three types of project abandonment. Complete termination of all activities on a project prior to full implementation is referred to as total abandonment. Substantial abandonment describes major truncation or simplification of the project to make it radically different from the original specification prior to full implementation. Finally, partial abandonment is used to describe reduction of the original scope of the project without entailing significant changes to the IS original specification, prior to full implementation.

In each case, the organisation should engage in another form of IS evaluation called here a post-mortem analysis. Collier and DeMarco (1996) equates the idea of what they call a post-mortem review with summative evaluation. They quote one of Alan Davies' 201 principles for software development:

> Principle 172: Conduct a post-mortem.... At the end of every project, give all the key project players a three or four-day assignment to analyse every problem that occurred during the project.

This should attempt to determine the key reasons for such total or partial failure. The results of such analysis are important in suggesting ways in which the organisation may improve its development practice. It is for this reason that the document produced from such a post-mortem analysis needs to be disseminated to senior management, project management and members of the project team. This, of course, can only be done effectively if assurances of non-recrimination are given to all project participants. Ideally, a reputable senior executive that was not involved in the project under consideration should conduct this analysis. Alternatively, an external body or consultant should undertake it.

Wherever possible post-mortem information should be made public. This is important in enabling the validation of IS development practice and the effective progression of the profession of IS.

### 4.4 Summative evaluation

The figure also emphasises another important organizational learning feedback loop. Even if a project reaches completion, it may fail in some sense when it comes to be delivered (what Lyytinen calls use failure).

Therefore, at some suitable time after a system has been delivered the organisation should engage in a summative evaluation of the system and its project. One framework proposed for the summative evaluation of IS is *benefits management* (Ward, 1990). Even at this point it is possible that the system may be wholly or partially abandoned, in which case it should also be the subject of a post-mortem analysis, as above.

It is important to emphasise that no system is ever complete. A summative evaluation is likely to suggest a number of ways in which the system may be modified or extended – normally both classed as systems maintenance. This is the third feedback loop illustrated on the diagram. The conclusion is that effective evaluation leads to effective management of maintenance.

Kumar (1990) conducted an empirical study of the prevalence and form of evaluation of IS after they have been implemented amongst major companies in the US. Three major results are evident from the data he collected. The major reason for performing post-implementation evaluation amongst the companies he surveyed was the formalisation of the completion of the development project. Evaluation was treated as a major tactic in a project disengagement strategy. Much of the evaluation was managed and performed by those who had designed the system being implemented. The most frequently evaluated criteria seem to be that of information quality criteria (accuracy, timelines, adequacy and appropriateness) along with facilitating criteria such as user satisfaction and attitudes. Socio-technical criteria such as the system's impact on the user and the organisation were evaluated much less frequently.

Hirschheim and Smithson (1988) maintain that although there appears to be widespread agreement regarding the need to evaluate both products and processes of IS work, there is little agreement as to the appropriate ways of conducting such evaluations. In one sense, the area of evaluation is a very wide one, encompassing many processes that take place during the life of an IS project, including selection, procurement and testing. In their analysis of the literature on post-implementation evaluation they organise the material on a dimension beginning at those which take a highly rational and objective stance on the evaluation process and ending at those which regard evaluation as very subjective or political. They identified three approaches to evaluation.

Those who approach evaluation in terms of efficiency assume that the function and goals of evaluation are non-controversial and that the overall aim is to achieve precise measurement of performance, efficiency or reliability. A second approach is to look at evaluation in terms of effectiveness. This approach attempts to evaluate the effectiveness of IS in terms of usage or utility, costs and benefits, or some notions of increases in job satisfaction. The third approach looks at evaluation in terms of understanding. Here, the aim is to understand the function and aims of evaluation itself, particularly how evaluations are performed within the political and social environment of an organisation.

Evaluation in terms of understanding is clearly the perspective that lies closest to our emphasis on stakeholders and their expectations. A project should be continuously monitored in terms of the degree to which it is likely to satisfy stakeholder expectations. Also, at the completion of a project, the project needs to be evaluated in terms of what it tells the organisation about development processes.

Ideally, the issue of evaluation should be built into a project profile from the start. One clear way of doing this is to build in clear measures of success at the start of the project. This should indicate at some appropriate point clear and straightforward measurements we make to assess whether we have been successful or not.

### 4.5 Empirical study of evaluation activity in real-world settings

Compared to a vast amount of prescriptive material published there is little empirical work on IS evaluation (Ward and Taylor, 1996). An early attempt to validate elements of the model is described in some detail in Owens and Davies (1999). In this paper, an historical analysis of the evaluation activity conducted within a large-scale development project was undertaken. The paper examined the development and implementation of a two-phase mission-critical IS that spanned a decade of development work conducted by OTIS PLC.

The conclusions of this study found that a strategic evaluation had been undertaken as part of the initiation activity for phase one of the development project, but there was little evidence of systematic formative evaluation activity being conducted during this phase and no systematic summative evaluation was conducted after the implementation of phase one. An informal assessment of the success of the IS was made at the time, primarily in terms of meeting its functional specification and some vague expressions of user satisfaction with the system.

A number of problems gradually emerged in the 2 years of use of the IS after phase one and a second phase of development work was initiated. One could argue that this was an example of single-loop learning. However, no strategic evaluation is evident for this second phase. No form of summative evaluation was conducted after the implementation of the second phase of the project.

This study provides some evidence that organisations fail to take IS evaluation seriously. It is important to determine why this is the case. Some of the reasons applicable to OTIS were found to be a lack of sufficient people with the requisite expertise able to conduct effective evaluation; pressures exerted on the IS service by the business to get the system in quickly; and the perceived low status of evaluation activity amongst both business and IT staff within OTIS.

## 5. Conclusions and further work

In this paper, we have considered some of the inherent relationships between the literature on IS evaluation: that on IS failure and that on organizational learning. From such an analysis we have developed a model of IS evaluation that arises from this work and distinguished between a number of distinct types of IS evaluation. We have demonstrated a number of anchorage points for lessons from the literature on IS failure and indicated how each type of evaluation fits with the IS development life cycle.

Part of the reason for the low adoption rates of evaluation activity within organisations may be the current gap between other established IS development (ISD) approaches, methods, techniques and tools and the suggestions produced by the IS evaluation community. One direction for further work is therefore, to consider the degree to which it is feasible to integrate evaluation activity with existing methods for IS planning, project management and IS development. More specific questions and areas for further work are described below.

To what extent can we integrate our IS evaluation model with conventional ISD methods like structured systems analysis and design method (SSADM) or unified modelling language (UML)? To attempt this we first aim to convert our model into a more generic and transportable form as discussed in Dori (1995). We would like to discover as what degree do project management methods currently acknowledge evaluation as a process and to what extent can evaluation be melded with such approaches?

We would also like to discover to what extent does our model of evaluation fit with different models of the development life cycle than the linear model utilised in this paper. It might be argued that that the separation of evaluation from development activity is encouraged by linear models of the life cycle. However, our interest is in particularly examining large-scale development projects that while being the most likely to fail (Cash *et al.*, 1992) are also the most likely to be conducted in a linear manner. However, it is particularly important to assess the degree of efficacy of applying the model in iterative approaches such as rapid application development (Stapleton, 1997), particularly where such approaches are scaled-up to address larger projects.

A key question we wish to pursue in further work is to what degree organisations conform to our ideal-type? For actual projects, can we track the history of strategic, formative and summative evaluation activities in organisations? We are currently employing the model presented in this paper to evaluate a large IS development project at the National Assembly for Wales.

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