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Workshop: "Success and failure factors in health information systems development"

Jytte Brender, Aalborg University, Denmark

Abstract: This paper is an excerpt of a pilot Delphi study on factors influencing success and failure of Health Informatics Systems, viewed in the perspective of existing evaluation methods. The Delphi study resulted in a total of 110 success factors and 27 failure criteria, distributed on categories like functional, organizational, behavioural, technical, managerial, political, cultural, legal, strategy, economy, education and user acceptance. The main conclusion of the Delphi investigation was that all of these success factors and the failure criteria were considered relevant by the expert panel.

We view constructive evaluation, evaluation being the act of bringing about a decision-making basis, as the means to minimise failure and maximise success from the very beginning of the development or implementation. Considering that system development and implementation activities of for instance an electronic healthcare record are utterly complex and virtually non-deterministic, so are the evaluation activities to be employed. Based on these discussions, the challenges that evaluation and evaluators are facing are debated in view of existing evaluation methods.

INTRODUCTION

'Evaluation' is - formally defined - "acts related to measurement or exploration of a system's properties". Similarly, 'system' is defined as "all the components, attributes and relationships needed to accomplish an objective" by [Haimes & Schneiter 1996]. This definition is pretty important in our context as it points to health information systems as comprising much more than the technical construct[1]. Evaluation may be accomplished during planning, during development, or during the operation and maintenance of an IT-system. When put in its logical extreme, 'evaluation' merely means to put values to some properties of the system. However, putting values to measures has no sense as a self-contained and independent activity, and consequently, the purpose of evaluation shall reflect its context:

> *"Evaluation is the act of measuring or exploring properties of a health information system (in planning, development, implementation, or operation), the result of which informs a decision to be made concerning that system in a specific context"*
>
> (citation from [Ammenwerth et al. 2005])

Metaphorically speaking [Brender 2005b], evaluation is like a torch being waved in the dark in front of you: Evaluation may be used to screen for options, obstacles and barriers. It may be used to diagnose problems within a vast set of observations or to prognosticate risks, while monitoring success

[1)] We distinguish between an 'IT-system' and an 'IT-based solution'. The term 'IT-system' denotes the technical construct of the entire solution of a Health Informatics Application (hardware, software, including basic software, and communication network), while 'IT-based solution' (or 'Health Informatics Application') refers to the IT-system PLUS its surrounding organisation with its mission, conditions, structure, work processes, etc.

and failure factors. Subsequent to evaluation, it is the project management's responsibility to take initiatives regarding the treatment of identified obstacles and symptoms of failure by correcting, adapting and refining the trail of activities within the plan pursued.

As system development and implementation activities of for instance an electronic healthcare record are utterly complex and virtually non-deterministic, so are the evaluation activities to be employed. One may identify an infinite number of evaluation activities within the lifecycle of health information applications. A substantial number of evaluation methods exists, as demonstrated by [Brender 2005], but are not appropriately known to its target users, as argued in [Ammenwerth et al. 2004]. Similarly, a review of the evaluation literature with respect to pitfalls and perils in assessment of medical IT-based solutions concluded that the awareness of confounding aspects is insufficient [Brender 2003]. It is within this perspective that the objective of the present paper shall be seen: The aim of the paper is - in a first iteration - to view the success factors and failure criteria in the perspective of evaluation and available evaluation methods.

SUCCESS FACTORS AND FAILURE CRITERIA

In a forthcoming paper, [Brender et al. 2005], we present the results of a pilot Delphi study. A total of 110 success factors and 27 failure criteria were identified, rated quantitatively for the following system types: 'Administrative systems', 'Production Support Systems', 'Clinical Systems', 'Decision Support Systems' and 'Education & Training Systems'. The different factors are distributed in a hierarchical fashion on the following categories: functional, organizational, behavioural, technical, managerial, political, cultural, legal, strategy, economy, education and user acceptance.

Since evaluation is a means to provide a decision-making basis in some project development context, it is obvious to look at the identified success factors and failure criteria to correlate them with existing evaluation methods, as described in the Handbook of Evaluation Methods [Brender 2005].

Naturally not all success factors and failure criteria will need an explicit evaluation method to be assessed. Some of the factors correlate to simple 'yes/no' questions, i.e. they may constitute part of a checklist of issues for the project management to take into account at the planning. Others constitute study issues that prescribe an exploration of a qualitative nature, and others again prescribe quantitative assessment. It is the latter two categories that we will address in this brief overview, and only the most salient examples will be shown here to indicate the width of aspects that needs to be taken into account at the preparation of an evaluation plan for a project, and to illustrate that relevant methods do exist, but also that further research work is needed to make these fully comply with the evaluation questions and the needs of different types of systems as discussed in [Brender 2005b]

'Success' for a Health Informatics Application means that a combination of the following aspects are more or less fulfilled for the IT-based solution (from [Brender et al. 2005]):

- *It is widely acknowledged and used in daily practice; users are willing to contribute to improvements*
- *It fulfils the role and tasks it was planned for in the environment where it is used and for those users who are using it*
- *It supports good medical practice, and hence benefits the patient*
- *It benefits the healthcare organisation and the conditions of work for its personnel, or at least a significant proportion of them, without penalizing the other ones or, similarly, without hampering other significant aspects*
- *It can easily be upgraded to cope with the evolution of healthcare technology and practice as well as to manage emerging demands*

Further from [Brender et al. 2005], "'Success' is not static, it evolves": Parts of the aspects determining success reside within the many processes leading to the final operational solution, while others are built into the outcome from the very beginning of the conception of a solution, the actual design or selection of a particular solution. Like 'success', 'failure' is not black & white. Failure of a health informatics application is either due to the non-fulfilment of the defined success aspect or a set of specific criteria that - if present - more or less guarantees failure to achieve one's goals.

Since neither of the two is normally truly built into the development plan, but is the result of a development process, it makes sense that constructive evaluation may provide the means to optimise the success and minimize the degree of failure. The evaluator may be in one of two project situations: prospectively providing a prognostic decision-making basis or retrospectively providing a diagnostic elucidation of root causes for problems needing responsive actions (screening and monitoring are essentially diagnostic activities).

Success factors

A significant proportion of the success factors has been cut out for the reason described above, and others have been merged in the below to pack together the table. Still, this list will only include salient examples and hence has been cut even further.

Success Factors			**Comments and suggestions for evaluation methods that may be applicable (in *Italics*, from [Brender 2005])**
Functional	Careful preparation of the User Requirements Specification to appropriate and balanced take into account and express users' requirements, needs as well as demands	(in general)	*Requirements Assessment* addresses issues like feasibility, verifiability, completeness, and alike, and whether the solution described in terms of the User Requirements Specification is the right one ('relevance'). However, to fully assess whether a solution based on the specification will fulfil the users' needs is a difficult issue, requiring an objective and perceptive person with the ability to identify options and obstacles within the organisation and its work procedures. The methods for *Analysis of Work Procedures* might be of value here.
		Fulfil the needs (whether stated or not) rather than only the requirements of the users	
	Alignment of the role and design of the IT-system	The functionality has to be compatible with the users' way of thinking (cognitive aspects)	Several *Usability* approaches may be applied in this respect: • *Cognitive Assessment* • *Cognitive Walkthrough* • *Heuristic Evaluation* • *Think Aloud*
		The system has to be usable and useful, helping the user in his/her daily routine work	See *Analysis of Work Procedures* and *Functionality Assessment*
		Coverage of daily practice has to be sufficient, compared with the defined role of the IT-system	
		The IT-system must support the users in accomplishing the primary goal of their activities	
Organisational	Work from the workflow	Planning of new procedures must appropriately take existing patterns of collaboration into account	*Social Network Analysis* addresses the relations between elements within an organization (such as individuals, professions, departments or other organizations), which will influence the acceptance and use of an IT-based solution

		The users show a willingness to change practise	*Organisational Readiness* (prognostic), *Field Study* (screening and monitoring), *Equity Implementation Model* (diagnostic)
Behav ioural	The personal attitude, engagement and commitment	Users, managers and others	*Interviews* are particularly suited for elucidation of individuals' opinions, attitudes and perceptions regarding phenomena and observations
Cultural	Preparedness and willingness towards cultural change	In general, and with respect to: • Awareness of the need for cultural change • Readiness for a potential new business model • Readiness for solutions not invented in-house	*Organisational Readiness* is a method designed for this, however, the impression is that it is not yet a fully matured method
Management	Management support	Setting goals and courses	*Balanced Score Card* is based on such information, so using the established set will reveal if goals and courses are defined in a useful way. *Framework for Assessment of Strategies* is used to analysing the individual goals and courses. *KUBI* is based on a set of user or customer/client defined value norms and objectives, and hence the one set may serve as the frame of reference for the other set of goals and courses, to identify inadequacies.
		Understanding the return of investment (whether material and/or immaterial benefits)	Besides the economic assessment of material benefits, the issue here is the awareness and valuing of anticipated immaterial outcomes. A *Delphi* investigation may reveal immaterial benefits and attitudes in their respect
	Flexible planning	Realistic time lines	Judging whether time lines are realistic is a matter of experience with system development and implementation, and sufficient insight into the given project
		Understanding that implementation of an IT-based solution is a non-linear (indeter-ministic) process	Evaluation in both respects would be *Root Causes Analysis*, investigating the project history, events and initiatives to identify the pattern of problems and actions
		Response to shortcomings is constructive	
	Prospective and proactive control	Stringent risk management	*Risk Assessment* has to be visible and an explicit element within the planning, providing in an ongoing fashion the project management with the information relevant to monitor and take necessary actions upon events
		Appropriate action in response to unanticipated events	Like for the aspects under 'Flexible planning' above
	User involvement	(in general)	A *Stakeholder Analysis* might be valuable, but has to take into account the culture and practice within the organisation
	Strategy	In general, and in particular with respect to: • Synergy between initiatives	Judging the management's strategy in general is a very delicate issue, the outcome of which may make the management vulnerable. Judgment of feasibility and time lines may be formally assessed by means of the *Framework for Assessment of Strategies*. Judgment of the synergy between initiatives is a matter of identifying the borders between relevant initiatives to identify the formal and informal flow of information

	Handling the diversity within stakeholder goals	Awareness and mediation of diverging goals	A *Stakeholder Analysis* is necessary to get a rich picture of individual stakeholder goals and interests, also to get an idea of the beneficiaries and victims of the new solution. Following that, the decision making and manoeuvring is a management issue.
		Handling of hidden agendas	
Technical	Standard based		Identifying relevant standards is a specialised expertise and following that *Technical Verification* may reveal compliance
	Data validity procedures are part of system qualities		*Technical Verification* (this is part of what one would expect to belong under 'good practice' within systems development
	Usability		Several *Usability* approaches may be applied in this respect: • *Cognitive Assessment* • *Cognitive Walkthrough* • *Heuristic Evaluation* • *Think Aloud* • *Video-recording*
	Integrated functionality	Integration with legacy system	This belongs within the evaluation type called *Technical verification*, but may require special technical skills
		Interoperability (i.e. connected systems are logically and functionally co-operating in real-time)	Assessment wise, it is considered part of the *Technical Verification*. This is one of the really difficult technical aspects to assess, because it is very dependent on timing between logically interoperating systems, such as interoperating legacy systems. Assessment for interoperability should be completed for all kinds of requesting, cancelling, modifying and reporting transactions between two interoperating systems, to verify that timing is not an issue in practice in the functionality of a given application.
	Communication standards	Interconnectivity	This belongs within the evaluation type called *Technical Verification*, but may require special technical skills
	Flexibility and adaptability, enabling future functional and technical changes		This belongs within the evaluation type called *Technical Verification*, but may require special technical skills combined with domain insight
Legal aspects	Know what the legal constraints /opportunities are		This belongs within the evaluation type called *Technical verification*, but requires special legal insight into the problem area
Strategy	Organisational		*Framework for assessment of strategies*
	Accepted also at lower levels		*Focus Group Interview* as interviews in general are particularly suited for elucidation of individuals' opinions, attitudes and perceptions regarding phenomena and observations. In particular, the *Focus Group Interview* is suited, when a model solution is being discussed and established.
Economy	There has to be a return of investment (whether material or immaterial)		This requires an economic investigation, carefully balanced with the delicate immaterial values that can not or can only in a much larger community perspective be subject to an economic investigation. Healthcare economics is a discipline in itself and excluded from [Brender 2005]. See also above under the issue of Management Support

User accepta			Evaluation of User Acceptance is so often met in the literature, and very often measured by means of *Questionnaires*, see [Brender 2005]

Failure Criteria

Failure Criteria			Comments and suggestions for evaluation methods that may be applicable (in ***Italics***, from [Brender 2005])
Functional	The system does not meet expectations		*Root Causes Analysis* is of value to explore what, how and why a given incident occurred to identify the root cause of undesirable events.
	Limitations in the way the user can express his/herself		This is closely related to the cognitive aspects and assumes insight into job tasks before an investigation can be made. So, prospectively it requires an *Analysis of Work Procedures* and retrospectively in case of serious problems it requires a combination of a *Field Study*, supported by methods addressing *Usability* aspects: • *Cognitive Assessment* • *Cognitive Walkthrough* • *Heuristic Evaluation* • *Think Aloud* • *Video-recording*
Organisational	Not understanding the organisational context	Not understanding or foreseeing the extent to which the new IT-system affects the organisation, its structure and/or work procedures	Methods for forecasting the extent to which the work procedures will change is considered an aspect of the development planning tools and techniques rather than dedicated evaluation tools. However, a *Future Workshop* may provide some information in this respect.
		Too many changes of work procedures	
		Analysts dominate the development at the expense of those understanding the organisational context	A *Stakeholder Analysis* will reveal stakeholder features and their inner dynamics, and normally has the purpose of identifying participants for the completion of a given task, problem solving activity or project.
Behavioral	Overloading the user		Related to *Usability* aspects: • *Cognitive Assessment* • *Cognitive Walkthrough* • *Heuristic Evaluation* • *Think Aloud* • *Video-recording*
	Underestimating user acceptance		*User Acceptance and Satisfaction* approaches

	Resistance because of fear or loss of control of own job situation		*Focus Group Interview* as interviews in general are particularly suited for elucidation of individuals' opinions, attitudes and perceptions regarding phenomena and observations.
Cultural	Assuming that what works at one place also works somewhere else		A study of transferability may involve almost any existing evaluation method, presumably *Analysis of Work Procedures* and *Functionality Assessment* will come closest to the information need
	Users have too high expectations		*Interviews* are particularly suited for elucidation of individuals' opinions, attitudes and perceptions
Technical	Limitations in the way the user can express his/herself		Here it is related to the technical aspects of the functionality, while above it is related to the functional aspects. Hence, it is entirely related to to *Usability* aspects: • *Cognitive Assessment* • *Cognitive Walkthrough* • *Heuristic Evaluation* • *Think Aloud*
	Response rate and other performance measures	(in general)	*Technical verification*, but this may require deep functional insight to define the workload and the measurement approach
		The time needed to complete the users' tasks is increased	This requires before-and-after time-motion studies (time measurement of paradigm use scenarios)
	Vendor did not support the functionality quoted		*Technical Verification* with the contract as the frame of reference. The rest is up to a legal action.
	Insufficient verification of conformity with requirements specification		A thorough preventive action in this respect is *Technical Verification*
Legal	Low concern on regulations and standards		An attitudinal investigation is often performed my means of *Interviews*
	Compliance with laws and existing ethical rules of conduct		This requires special legal insight into the problem area
Education	Visible discrepancy between successive versions of the IT-system		There is no evaluation methods dedicated to assess this symptom of evolution, which may be short-term or long-term. 'Visible discrepancy between successive versions' will result in temporary inefficiency in the operation of the system accompanied by operational errors and hence is an undesirable situation that has to be balanced against the gain from evolution of the functionality. The problem may instead be a lack of communication or a lack of understanding or foreseeing the extent to which the new changes affects the organisation, its structure and/or work procedures, thereby hampering proactive educational activities.

DISCUSSION

It seems feasible to identify approaches that may be applied for most of the issues mentioned. However, as viewed from a project management perspective several of them are designed to provide exhaustive and strictly valid information, implying that a lot of calendar time and resources is required. Consequently, in a practical project development context the challenge may some times be to modify or simplify the evaluation methods to the practical information need. After all, it is not every evaluation study that strives to become published as a scientific investigation. However, at lot of the methods gathered in [Brender 2005] do have this option of being applied at several levels of complexity.

As the success and failure aspects were formulated in the Delphi investigation there is clearly a distinction between prospective and retrospective purposes of the evaluation. In case of the former, the prognosis enabled by constructive evaluation my guide the planning or revision of the development process, for instance by means of methods addressing the failure criteria "Too many changes of work procedures". The retrospective information needs seems better supported by some specific evaluation methods, focussing on exploration of deviations from a desired situation, like Root Causes Analysis and Functionality Assessment.

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