Factors Influencing Success and Failure of Health Informatics Systems*

A Pilot Delphi Study

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Summary

Objectives: The aim is to gain information on factors influencing success and failure for Health Informatics applications from a group of medical informaticians.

Methods: Based on the presentations at a special topic conference on success and failure in Health ICT and analysis of the proceedings, we conducted a Delphi study on success and failure aspects.

Results: A total of 110 success factors and 27 failure criteria were identified, distributed on categories like functional, organizational, behavioral, technical, managerial, political, cultural, legal, strategy, economy, education and user acceptance. These factors and criteria were rated for six different system types. Unanimously it was agreed that "collaboration and co-operation" and "setting goals and courses" are "essential for the success" of clinical systems, and "user acceptance" for educational systems. Similarly, the score "essential in order to avoid a failure" were given unanimously on clinical systems for "response rate and other performance measures" and on administrative systems for "not understanding the organizational context" with "not understanding or foreseeing the extent to which the new IT-system affects the organization, its structure and/or work procedures" as the highest scoring sub-item.

Conclusions: All success factors and failure criteria were considered relevant by the Delphi expert panel. There is no small set of relevant factors or indicators, but success or failure of a Health ICT depends on a large set of issues. Further, clinical systems and decision support systems depend on more factors than other systems.

Keywords

Success, failure, systems development, Delphi

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Introduction

Developing information systems (IS) is a difficult task and the process often leads to a failure instead of a success. A study of 8000 IS projects in 352 US companies showed that more than half of the IS development projects failed in one way or another [1]. Understanding the underlying causes why one development leads to a success and another to a failure may help us improve the efficiency of IS deployment in health care.

Failures can emerge in various phases of the development and implementation process: failure to technically complete an appropriate system, failure to get the system accepted by the users and failure to integrate the system in the organizational and user environment.

Reasons for IS development failures may originate from difficulties in defining system objectives, selection of non-suitable technology for implementation, problems in estimating the development costs or the system's economical impacts, failure to consider the organizational aspects of the system and problems with the development process such as lacking commitment to the development project or lacking understanding of the development process itself [2]. Commitment to the IS development project has also been identified as a success factor for the IS development by others as well [3-5].

Information system use failures may arise from technical reasons and from data and information problems. The user may perceive that the presented data and information is irrelevant, too narrow in coverage or not specific enough. Conceptual misunderstandings may also lead to failure; the system does not solve the real problem or there are misunderstandings regarding the required functionalities.

In many studies, information systems success is related to how well the IS interfaces with the **organizational and user environments** [6, 7]. We have argued before that one cannot consider the technical artefact at its own; it is when it is implemented and used in a specific environment that its value can be assessed [8].

DeLone and McLean [9, 10] found that if the system's quality and the information quality are good then the system will be used and the user satisfaction improves, and these have positive impacts on the individual user and also positive organizational impacts. To achieve good system quality and information quality attention has to be paid to the system characteristics in the IS development process such as usability, reliability and suitability for the purpose, and on the information quality referring to information content, information coverage and relevance. In their more advanced model [11] they add on a success factor like service quality, which refers to the service provided by the system to the customer.

* Additional data available for free at URL http://www.methods-online.com

A review of success determinants within the medical informatics literature explicitly takes DeLone and McLean's original framework as their analytical framework and operates with some 50 component aspects, yet some of these quite specific and with fine granularity, like 'documentation frequency' (see [12]). From an analysis of failed initiatives they found a number of factors that could not be categorized with DeLone and McLean's framework: The categories 'system development', 'implementation process' and 'culture and characteristics of the organization', each including a number of factors.

A survey of barriers further indicated 'economy' and 'vendor/product immaturity' as significant factors at the senior management level [13].

The three reviews of success and failure factors [14-16] were summarized in [17]. They all conclude that the organizational environment includes highly significant obstacles and barriers to a successful implementation of IT-based solutions. Hence, strong predictors of successful implementation are to be expected among people/behavioural aspects, management and communication, as well as the implementation process and change management rather than among the technical issues.

The literature points to various groups of factors for success and failure that can be roughly categorized into functional, organizational, technical, managerial, cultural, legal and other aspects. This is very well in line with the various evaluation aspects that have been proposed by Jørgensen [18] and Stoop and Berg [19].

The EFMI Special Topic Conference 2004

The aim of the Special Topic Conference 2004, taking place in June 2004 in Munich, was to discuss success and failure criteria for IT systems in health care (see the proceedings [20] and the other papers in this special issue) and, if possible, come to a kind of consensus on the most important factors. Several examples of success and failure criteria from various case studies from various European countries were presented at the conference. Table 1 summarizes some of the main factors for success and failure as discussed in the various contributions, structured according to the above-mentioned categorization.

Not surprisingly, no contribution addressed all different factors in their case study analysis, as, depending on the context of a project, the papers each have an individual focus on which factors were most important in their studies. Still most papers address more than one group of factors, and several of the factors are addressed by more than one contribution.

During the conference, each conference session had a rapporteur, summarizing and synthesizing the messages of the contributions in their section. Following this summary presentation, a lively interactive panel discussion with the audience took place. During this session all failure and success factors that were raised were recorded and structured. The time slot, however, was too short to bring the discussion on success and failure factors to an end. Consequently, it was decided to finalize and conclude the discussion by means of a Delphi study involving the conference participants. The study purpose was to elicit the participants' combined experience with respect to factors indicating a successful health informatics application, or the opposite.

Aim of this Paper

The aim of this paper is to report on the Delphi study to gain more detailed information on success and failure factors for health informatics applications.

Table 1 Main factors for success and failure of health informatics applications, as identified in the special issue contributions, see this entire volume. An '*' indicates factors being discussed in more than one contribution

Type of criteria	Examples
Functional	• Functionality: Comprehensive functionality, Supports various ways of system use, Balance between new functionality and stability*, User-tailored ICT • Usability: High usability*, Good fit between user and system, Intuitive user interface, Not too many different screens*
Organizational	• Historical Context: Earlier positive experience with new way of working, Previous experiences of users with ICT • Fit of perceived cost and benefit: ICT answers perceived, continuous need*, Positive cost-benefit perceptions of users*, Positive influence on patient care, Patients feels benefit, too*, Balance between expectations and ICT outcome • Support of workflow: ICT supports core process of patient care , ICT embedded in clinical workflow, ICT supports concrete clinical tasks, Activities made easier through ICT*, Reduction of routine documentation activities, Not too many changes on work organization and workload*
Technical	• Development process: Development in small teams, Continuous user involvement and user participation*, Sufficiently modeling health care processes, Use of open standards • System Architecture: Flexible system concept*, Modular and scalable system concept*, Good interoperability and integration with other ICT systems*, Low complexity of the overall system* • Technology: Stable, not too innovative technologies*, Affordable technologies, Easy-to-use devices
Managerial	• Sufficient funding available • Good and flexible project management: Strong motivation of project team, Good public relation of project team, No interpersonal tensions in project team, Use of tools for project management • ICT Introduction: Availability of skilled IT staff, Sufficient user training and user education*, Extensive user support*
Cultural	• Availability of promoters with a vision: Active marketing of new system, Forming a support based for change, Support through various user groups, Conviction of project idea* • Openness to change and innovation: Acceptance of new way of care delivery, Acceptance of standardized way of care delivery, Not too independent professional status of users, Alignment of individual goals with institutional goals
Legal	• Appropriate legislation, Willingness for health care reforms, Willingness to change legislation, Involvement of ICT expert in legislation committees, Health authorities promote innovation

Methods and Material

The Delphi Study Question

The main question of the study was: "What are main factors for success and failure for health informatics applications?"

Study Approach

The basic approach of a Delphi study is the phased interaction between an expert panel and a neutral core team. The two parties iterate to incrementally proceed from a study question towards a final quantitative rating by the expert panel of items in a questionnaire. It is the joint effort by many experts with the knowledge of their (sub)domain that brings forth the result: The experts adjust one another in successive feedback rounds, leading to a rather accurate answer to the study question. Although the Delphi method has been developed outside the medical domain, it has been used in various studies in medical informatics on diverse topics, including defining common standards for quantitative electrocardiography [21], defining structured descriptions of epileptic seizures [22] and validating consensus on medical diagnostic knowledge [23]. The Delphi approach is a family of methods, with the neutral core team, an expert panel and the iteration in common; see [24-27] for further instructions, applications and examples.

Inclusion and Exclusion Criteria for Delphi Study Participants

Prior to the conference, a public call for papers was announced. The authors of accepted papers were instructed to make revisions to their papers such that they would contribute to the focus of the conference on eliciting experience on success and failure criteria for health informatics applications in general.

The inclusion criterion for participants of the Delphi study was that 'the participants had been physically present at the conference, whether or not presenting themselves', thereby ruling out the option of including known but absent frontier medical informaticians. This criterion was based on the philosophy that the participants at the special topic conference have a special context for answering, and have gained some level of a common understanding of the concepts: They have heard the many viewpoints from different presenters, and took part in the discussions and thereby have witnessed the focus of the entire conference. Excluded were participants who were present for less than one conference day. Members of the core team were also excluded from the expert panel, although they all fulfilled the inclusion criteria as to allow them to focus on the Delphi process rather than on the details of the content.

Steps of the Delphi Study

The Delphi study was structured as follows:

1) Establishment of a **preliminary questionnaire**, based on the conference's presentations, resulting in a candidate list of success and failure factors (finalized June 2004 and distributed by E-mail to the expert panel). Suggestions for the definition of success and failure were also included
2) Acquiring **qualitative feedback** on the preliminary questionnaire by the Delphi study participants (finalized August 2004). The purpose of this phase was to achieve a comprehensive list of accepted and relevant concepts and definitions to be used in the next steps of the Delphi study. To minimize the effort by the experts, they were asked to mark the most important and the most irrelevant criteria, inviting them to comment where fitting
3) Generation of the **final questionnaire** through analysis of the feedback to the preliminary questionnaire. Question marks (the core team's or the experts') or otherwise open-ended issues in the input

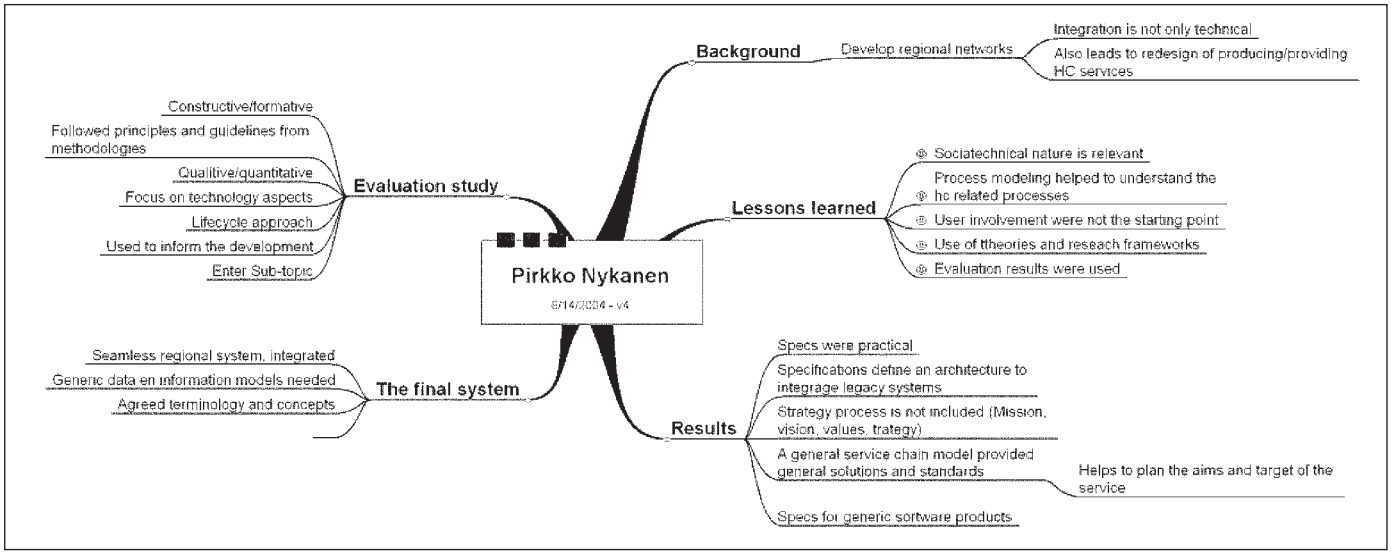

Fig. 1 Example of a mind map elicited during the MIE2004 STC Conference

Table 2 Extract from the preliminary questionnaire: List of candidate items for organizational success factors

Main topic	Success criterion	Specific criterion	Exclude as insignificant!	Your elaboration, opinion or other comments
Organisational	Understand the context	(in general)		
		Understanding what implementation really means for the organisation		
	Collaboration and cooperation			
	Make implementation a clear process			
	Work from the workflow	(in general, at the design of the IT-solution)		
		Taking existing patterns of collaboration into account		
		Willingness to change practise		
	High competences	(in general)		
		Involvement of consulting services		
	Support from higher level organisations (regional/national institutes)			
	Collaboration with industry	(in general)		
		Medical Informatician in hospital		

were clarified bilaterally with the contributor whenever relevant. This was, however, only necessary in a few instances. All contributions of participants were dealt with in an anonymous way to ensure neutrality and at once to prevent concept drift.

4) **Quantitative rating of all the success and failure aspects** listed in the final questionnaire to elicit their respective criticality. The final questionnaire was submitted to the expert panel by E-mail primo September 2004. Again, the material was extensive, so the instruction to the participants was to focus on their specific area of expertise or type of system. The collection of contributions from the experts was finalized primo December 2004.

Analysis

As the data are of a categorical type with missing data, and expected to be neither normally distributed nor mutually independent, the method for analysis of the collected ratings is descriptive. In order to assess the consistency of the responses for each type of system and for success and failure aspects separately the interclass correlation coefficient (ICC, equivalent with Cronbach's alpha) was computed. Since we had to deal with missing values and the ICC requires complete cases we successively eliminated the participants with the highest number of missing values until at least 70% of the items were included in the analysis.

Results

Step 1: Establishment of the Preliminary Questionnaire

Three sources of input were combined to establish the preliminary questionnaire with the candidate list of success and failure aspects as well as definitions:

a) mind maps[a] from the individual presentations, as well as a mind map developed live on the screen as part of the round table discussion at the end of the STC 2004 conference. The round table mind map is considered incomplete because it reflects the discussion rather than a systematic review of all possible factors. Figure 1 shows one example of a mind map elicited during the conference;
b) the proceedings, excluding [17] as this keynote includes a review that is included above as a kind of frame of reference from the literature in general;
c) dedicated note taking live from all presentations by the authors of this paper.

As a result of this phase, a preliminary questionnaire with 109 success and 34 failure factors was obtained and classified into functional, organizational, behavioral, cultural, political, management, technical, legal, economic and educational factors. Table 2 shows the questionnaire for the organizational factors as an example.

Step 2: Acquiring Qualitative Feedback on the Preliminary Questionnaire

The conference had 73 participants (of which six were three couples, pairwise working in the same institution). Upon explicit request to participate in this Delphi study, six abstained, three were excluded because of the in-/exclusion criteria, two were excluded because of persistent E-mail prob-

[a] The concept and ideas on mind maps are described in [28].

lems, and 19 explicitly agreed to participate in the Delphi study, including one of the couples (counted as only one).

The questionnaire was submitted to everyone who either had agreed to participate or who had not responded to the request to participate. Eighteen contributions were received plus one that only dealt with the definitions of success and failure. One came too late to be included. Of these 17 contributions, 11 respondents came from the group of 19 agreeing to participate.

Step 3: Generation of the Final Questionnaire

Each aspect in the preliminary questionnaire was reviewed and where needed modified, taking the comments of the 17 respondents into account. An item on the list was only deleted in case of consensus among the experts that the given item was irrelevant. The reason for being careful not to cut too much is that everything would be rated in the final round. All suggestions for additional items were included in the final questionnaire, and three additional main topics were added: publicity, strategy and user acceptance aspects.

Excluded completely from the candidate list were seven success factors: 'Focus on data generation processes is more important than data usage', 'Well defined functions may be easier to implement', 'Things that are difficult to do without computers', 'Leading edge functionality', 'Collaboration with industry', 'Natural language processing', and 'In the end one looks at the bottom line'. Only one failure criterion was completely deleted: 'Interference with work processes for e.g. experimental purposes', while a number were revised and moved to the list of success factors. The end result was 110 success and 27 failure factors.

Result on Definition of Success and Failure

The conclusion from the first feedback round of the Delphi study is that the concept of 'Success' cannot be characterized along one single axis:

'Success' for a Health Informatics Application means that a combination of the following aspects are more or less fulfilled for the IT-based solution[b]:

- 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 organization 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.

"'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 aspects or a set of specific criteria that – if present – more or less guarantees failure in achieving one's goals.

As a result of these definitions, we decided to name the success aspects 'factors', determining the degree of success and failure, while the explicit aspects of 'failure' listed separately have the nature of 'criteria'.

Result on List of Success Factors and Failure Criteria

The result of Step 3 was a consensus-based questionnaire to rate the identified success factors and failure criteria. The number of success factors was 110, divided into 12 sections. The number of failure criteria was 27, distributed on the same sections. The items of the final questionnaire are presented in Tables 3 and 4.

The final questionnaire was structured with a matrix of different types of health informatics applications to elicit potential differences:

- 'Administrative systems': for instance Hospital Information Systems and Patient Administrative Systems, for which the main part of the functionality has administrative, clinical (clerical) purposes, including booking
- 'Production Support Systems': for instance Laboratory Information Systems, Radiology Information Systems and PACS, with a significant element of support of the analytical production or image processing
- 'Clinical Systems': for instance Electronic Healthcare Records (Electronic Patient Records)
- 'Decision Support Systems': for instance all kinds of knowledge-based systems, decision support systems and expert systems
- 'Education and Training Systems'
- 'Misc.': any other application that does not immediately fall into any of the other categories

The scoring system for success factors was:
1) "Essential for the success of a Health Informatics Application"
2) "Central for success in most cases"
3) "Important for success in general"
4) "Sometimes relevant for success"
5) "Not really important for the success of Health Informatics Applications"

The scoring system for failure criteria was:
1) "Essential in order to avoid a failure for a Health Informatics Application"
2) "Central in order to avoid a failure in most cases"
3) "Important in order to avoid a failure in general"
4) "Sometimes relevant in order to avoid a failure"
5) "Not really important for failures of Health Informatics Applications"

[b] 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 organization with its mission, conditions, structure, work processes, etc.

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)
		Fulfill the needs (whether stated or not) rather than only the requirements of the users
		Enable and allow ongoing extension, while carefully controlling the aspect of moving targets
	Alignment of the role and design of the IT-system	The system has to be usable and useful, helping the user in his/her daily routine work
		The role and the design of the system have to comply with the organisational context, including structure, people, information flow and external links
		The IT-system has to be compatible with the organisation's daily practice
		Semantic understanding of the application domain
		The socio-technical nature of health information systems is understood
		The functionality has to be compatible with the users' way of thinking (cognitive aspects)
		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
		Find and address a real, high-impact problem area rather than a borderline problem area
	Coping with the complexity	The implementation project should apply explicit means for coping with the complexity
		Keep it simple, but not simpler than needed
		Evolutionary or incremental development as an approach to cope with complexity, including the educational aspect
	Flexibility towards dynamic changes and changes in the organisational context	
	Added functionality are provided by the IT-system, enabling users to provide new or better services	(in general)
		The incentive for the user (and stakeholders in general) must be clear and visible
Organisational	Collaboration and cooperation	(in general)
		Collaboration with Medical Informaticians within the hospital
		Developers get active and continuous feedback
		Emphasis is on establishing trust and collaboration rather than literal focus on the contract
	Make implementation a transparent process within the organisation	(in general)
		Generally open for debate
	Work from the workflow	The design of the IT-solution should start by considering the existing workflow
		Planning of new procedures must appropriately take existing patterns of collaboration into account
		Organisational changes induced by the IT-system should be minimised
		The users show a willingness to change practise
	High competences	It is important to involve people with experience from working on similar problems
	Support from higher level organisations (regional / national institutes)	

Table 3A
The list of success factors and their sub-items, grouped under category. See also Table 3B with more details published on the website of *Methods* (www.methods-online.com).

Table 3A Continued

Behavioural	The users are key	(in general)
	The personal attitude, engagement and commitment	Users
		Managers
		Other stakeholders
	Motivational activities	
Cultural	(in general)	
	Understand medicine and healthcare in general as a separate culture	
	Understand the local culture	
	Preparedness and willingness towards cultural change	(in general)
		Awareness of the need for cultural change
		Readiness for a potential new business model
		Readiness for solutions not invented in-house
Political	High-level commitment	(hospital/institution politics in general)
		High-level commitment in terms of a national strategy
		Political and institution-wide awareness of the necessity and/or benefits of new IT-system
		Willingness to invest
		Freedom (with responsibility) within budget
	Monitoring political implications	
	Considering IT-systems a service rather than a product from a vendor	
	Collaboration and concertation in providing new solutions	(in general)
		Sharing of concepts and regional and/or national data models
		Allying
	Transparency	
Management	Management support	(in general)
		Formulation and expression of a clear vision for the enterprise showing the IT-system as part of it
		The management is the committed to if not the initiator of the IT-project
		Setting goals and courses
		Understanding the return of investment (whether material and/or immaterial benefits)
		Also on the managerial decisions needs quality management
	Flexible planning	(in general)
		Enabling and allowing change of project plans and time tables
		Realistic time lines
		Understanding that implementation of an IT-based solution is a non-linear (indeterministic) process
		Response to shortcomings is constructive
	Prospective and proactive control	(Project management in general)
		A high degree of delegation and involvement combined with good coordination and communication
		Stringent risk management
		Cost-active control
		Coordination
		Appropriate action in response to unanticipated events
		Sanction bottom-up signals as valuable input for steering

Table 3A Continued

Management	Consider IT implementation as a change process	Acknowledging that the IT-system represents a chance to support a change in the care delivery process
		Stepwise progression rather than reengineering everything
		Good supervision to enable a smooth and continuous change management
	Coping with the impact of change	
	User involvement	(in general)
		Time must be freed or funding allocated for users to participate in the process
	Strategy	(in general)
		Continuity of projects
		Synergy between initiatives
	Communication	(in general)
		Information management and dissemination has to be organised
		Fast availability of information
	Handling the diversity within stakeholder goals	Awareness and mediation of diverging goals
		Handling of hidden agendas
		Withstanding undue pressure from stakeholders (including vendors)
Technical	Standard based	
	Data validity procedures are part of system qualities	
	Use proven technology	(except for certain research projects)
	Usability	
	Integrated functionality	All relevant software/hardware are available at the point of testing
		Integration with legacy system
		Interoperability (i.e. connected systems are logically and functionally co-operating in real-time)
	Communication standards	Interconnectivity
	Balance between flexibility and stability	
	Evolution rather than revolution	Stepwise progress following functional needs as well as technological achievements and potentials
	Flexibility and adaptability, enabling future functional and technical changes	
Legal aspects	Know what the legal constraints /opportunities are	
Strategy	National	
	Regional	
	Organisational	
	Accepted also at lower levels	
Economy	There has to be a return of investment (whether material or immaterial)	
	Justification of increase of costs	
	Sufficient funding	… for the implementation
		… for the maintenance
Education	(in general)	
	Sufficient training	(in general, to make the best out of the daily operation)
		Sufficient training to provide an understanding of its limitations and future potentials
User acceptance		

Step 4: Quantitative Rating of the Success Factors and Failure Criteria

The number of respondents in this phase was eight with rated contributions, one delivering a few scores plus qualitative feedback, and two who delivered only qualitative feedback. A number of experts within the panel responded that it was too much work for them to be able to contribute. With only a few exceptions, at least five respondents provided scores on success factors and failure criteria for the individual systems (excluding miscellaneous systems). 'Miscellaneous systems' as a system type is excluded as a whole because of too few ratings.

Given the deadline and the low response rate, it was decided not to pursue another iteration, and for both of these reasons the study shall not be taken for more than a pilot investigation.

Some interesting results are summarized in the following paragraphs, while the complete list of answers to the 137 items is shown on the website of *Methods of Information in Medicine* (http://www.methods-online.com).

There were no unanimous scores of "sometimes relevant" or "not really important" for either of the system types, showing that none of the 110 success factors and the 27 failure criteria was considered not relevant by the expert panel (see Tables 5 and 6).

There are differences in the rating of the different system types. A global view on the data shows that overall the impact of the factors on whether an IT-based solution will be a success or failure is considered to be larger for clinical and decision support systems than for the other types of systems.

Further, unanimous scores of "essential for the success" were only given for clinical systems for two success factors "collaboration and co-operation (in general)" and "setting goals and courses", and for educational systems for "user acceptance". Similarly, an unanimous score of "essential in order to avoid a failure" were given on clinical systems for "response rate and other performance measures"; and on administrative systems for "not understanding the organizational context (in general)" with "not understanding or foreseeing the extent to which the new IT-system affects the organization, its structure and/or work procedures" as the highest scoring sub-item.

Scores of high significance ('essential' or 'central' for success) were given for quite a number of items for all systems, with the maximum of 27% of all success factors registered for clinical systems: four functional (out of 18), four organizational (of 12), two behavioral (of 5), two cultural (of 7), one political (of 11), ten managerial (of 33), five technical (of 11), one educational (of 3) and one user acceptance (of 1) factor. Neither of

Table 4A The list of failure criteria and their sub-items, grouped under category. See also Table 4B with more details published on the website of *Methods* (www.methods-online.com).

Functional	The system does not meet expectations	
	Limitations in the way the user can express his/herself	
	Moving target	
Organisational	Not understanding the organisational context	(in general)
		Not understanding or foreseeing the extent to which the new IT-system affects the organisation, its structure and/or work procedures
		Too many changes of work procedures
		Analysts dominate the development at the expense of those understanding the organisational context
Behavioral	Overloading the user	
	Underestimating user acceptance	
	Resistance because of fear or loss of control of own job situation	
Cultural	Assuming that what works at one place also works somewhere else	
	Users have too high expectations	
Management	Overambitious implementation plans	Large-scale plan
	Judgement based on wrong premises	(in general)
		Assumptions not fulfilled
	Improper tendering	
	Business reorganisation of the vendor	
Technical	Limitations in the way the user can express his/herself	
	The technology is so restricted that it impacts design and implementation choices	
	Response rate and other performance measures	(in general)
		The time needed to complete the users' tasks is increased
	Vendor did not support the functionality quoted	
	Insufficient verification of conformity with requirements specification	
Legal	Low concern on regulations and standards	
	Compliance with laws and existing ethical rules of conduct	
Economy	Lacking financial power of a vendor	
Education	Visible discrepancy between successive versions of the IT-system	

Table 5 Overall distribution of scores on success factors for the different system types

	Adm. systems	Product. support systems	Clinical systems	Decision support systems	Education / training systems
Fraction of 'Essential'	0.30	0.34	0.41	0.41	0.36
Fraction of 'Central'	0.35	0.33	0.37	0.30	0.30
Fraction of 'Important'	0.23	0.22	0.16	0.20	0.21
Fraction of 'Sometimes relevant'	0.11	0.09	0.05	0.07	0.12
Fraction of 'Not really important'	0.02	0.01	0.01	0.02	0.01

Table 6 Overall distribution of scores on failure criteria for the different system types

	Adm. systems	Product. support systems	Clinical systems	Decision support systems	Education / training systems
Fraction of 'Essential'	0.24	0.28	0.40	0.40	0.27
Fraction of 'Central'	0.36	0.32	0.27	0.27	0.21
Fraction of 'Important'	0.29	0.31	0.27	0.20	0.19
Fraction of 'Sometimes relevant'	0.10	0.09	0.06	0.14	0.33
Fraction of 'Not really important'	0.01	0.01	0.01	0.00	0.00

Table 7 Interclass correlation coefficients for the ratings of the success indicators and failure criteria for the various types of systems.

Type of system	Type of items	Number of included participants	Number of items with complete data	ICC
Administrative systems	Success	6	91	0.359
	Failure	5	19	0.549
Production support systems	Success	6	90	0.408
	Failure	5	19	0.252
Clinical systems	Success	6	91	0.494
	Failure	5	19	--*
Decision support systems	Success	6	91	0.238
	Failure	5	19	--*
Education/training systems	Success	4	93	0.242
	Failure	3	20	0.235

* A negative ICC was found due to a negative average covariance among items. This violates reliability model assumptions and hence the results are not listed here.

the single legal factor, four strategy factors or four economic factors scored moderated unanimously. See Table 5 regarding details of the overall distribution of the scores.

Agreement on failure criteria of this high significance was also seen for clinical systems: one organizational (out of 4), two behavioral (of 3), four technical (of 6) and two legal (of 2). The single educational and economic criteria, two cultural, five managerial and three functional criteria were considered not that relevant. See Table 6 regarding details of the overall distribution of the scores.

The ICC scores are presented in Table 7. An ICC of 0.9 allows drawing conclusions at the item level, while in general an ICC of 0.8 is required to have global consistency among the participants. Our results indicate clearly that we are dealing with a pilot study. It also seems that the more widespread a system is in use, the higher the ICC.

Discussion

The contribution of this paper is that it attempts to get a quantitative grip on success and failure aspects of the implementation of IT-based solutions.

It was unanticipated that so many aspects could be extracted directly from the proceedings and the presentations of the STC, and that so few aspects were discarded as irrelevant in the first questionnaire round. The huge number of aspects was indeed a surprise. Even more surprising was that fewer success factors were deleted than added (changed from 109 to 110 factors) as a consequence of the experts' qualitative feedback in the first questionnaire round, and at the same time none of the 110 success factors or 27 failure criteria were considered irrelevant by the expert panel in the final rating.

Knowledge and hence experience is tacit to a large extent. A group interview in terms of the conference's interactive plenum discussion naturally will focus on what is presently at stake for the participants and what is brought into focus by the immediately preceding discussions. An advantage of our Delphi approach as compared to the interactive round table discussion may be that it enables the core team to pull the responder out of a specific context to elicit their accumulated (tacit) experience. However, the exhaustive list of aspects resulted in a large amount of work to be performed by the participants, and presumably led to the fairly low response rate. Thus, it may be questioned whether a Delphi approach was the right approach for this purpose, or whether the time constraints were prohibitive for a conference special issue on such a follow-up study. A reduction of the questionnaire to the main issues could have reduced the amount of work – and possibly lead to a

higher response rate –, but at the same time it would have reduced the granularity of the outcome.

It is debatable what the optimal point of view is for the questionnaire. It could, for instance, have been the view of work practices instead of the systems development perspective. The expert panel consisted mainly of medical informaticians. They bridge between the healthcare professionals, the administrative and political aspects and the technical viewpoints, while trying to take a holistic view of the situation rather than taking either of these as their main view. We believe that the medical informatics viewpoint is the preferred one, even if it is not about distinct applications but the ensemble that support work practices.

The list of issues has the connotation of a static nature of the issues. It is in no way static, rather the opposite: Decisions made at the beginning of an implementation may be sensible and fulfil most of the factors in the Delphi list in a good way, but may become constraining as time goes and the process evolves. Then, putting factors and types of systems in ratings may tempt the analyst to focus on leaves rather than root causes of failure, ignoring the intertwinement and interdependencies of the factors. However, since we don't yet know the significant independent variables in successful systems development, we have to refrain from discussing root causes of failure and success and concentrate on the experts' experience. The pattern of causal relations is dependent on a complex socio-technical system and has to be analyzed according to it. This socio-technical system, however, at present changes fairly rapidly as a function of time as the system development culture changes from past times' hierarchical, bureaucratic approaches with consultation and information of end users to participative approaches, see discussions in [29]. The Delphi study's expert panel covers several European cultures, from the Scandinavian to Mediterranean and Eastern European traditions; however, the population of respondents is too small to analyse whether the cultural variation is a significant factor in the global picture, as was seen in the PriceWaterhouse investigation, [16].

Our results emphasise the importance of individual and organizational success factors. The well-known IS success model [9] presents the information systems' success as a dependent variable in information systems research and concludes that, as we have concluded, success is a multidimensional construct. This model relates IS success both to the system functionality and to the system use environment. Many of the models referenced in the Introduction discuss the success and failure in relation to the development process and development environment, but some studies relate IS success to organizational and user environments, especially on the features, which determine the interface between the information system and its environment. The importance of these aspects is also discussed in a review by [30], where they argue that, integral to the health information system's success, is the system functionality and a mix of organizational, behavioural and social issues that cover clinical context, cognitive factors, methods of development and dissemination. Success and failure are not only technological or political questions. The reasons for failures and successes are more often found in human-related, social and organizational aspects of the systems development and use. Our Delphi study supports these findings in emphasising the importance of aspects related to the health information system's organizational environment.

It is evident that users may emphasise different success factors depending on the type of the system to be evaluated and on the system usage situation. It would be beneficial in empirical success and failure studies to select the most descriptive factors for the situation and to keep the number of measures rather low in order to be able to compare research results and findings.

Conclusion

The main conclusion of the present paper is that none of the 110 success factors and the 27 failure criteria identified were considered irrelevant by the expert panel. This entails that success and failure are complex issues and an actual success or failure will have various factors contributing to the final result. The study does not address causal relations and interferences among the individual factors, as this is yet unknown territory.

There are differences in the rating of the different system types, emphasising one factor for one system while considering the same factors less significant for other system types. Overall it seems that the success factors and failure criteria are considered most significant for clinical systems. It may be concluded that to make a clinical system or a decision support system successful depends on many more factors than for other systems.

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