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An expanded instrument for evaluating information system success

Timo Saarinen[1]

Helsinki School of Economics, Runeberginkatu 14-16, FIN-00100 Helsinki, Finland

Abstract

Economic and quantitative measures for the success of Information Systems (IS) are difficult to obtain. Researchers and practitioners often rely on subjective assessment and surrogate measures, such as the user information satisfaction (UIS) instrument. The UIS instrument has been widely accepted even though criticized for neglecting the essential issues related to the success of IS. It measures success only indirectly, by assessing the quality of the IS product and related services. By extending the measure of success to also include the development process (standing for the investment costs and efficient use of the resources) and the impact of the IS on the organization (standing for the benefits of the investment), we allow for a more comprehensive and direct assessment of the IS development projects that better conforms to the idea of a traditional cost-benefit analysis, relevant to the managers responsible for the IS investments. Measurement scales for the resulting four dimensions of success—the development process, use process, IS product quality and impact of the IS on the organization—were developed and tested for reliability and validity, by studying the IS development projects in major Finnish companies.

Keywords: Effectiveness; Information systems; Success; User information satisfaction

1. Introduction

Considerable resources, invested by organizations in information systems (IS), stress the importance of success evaluation for both practitioners and researchers. In principle, traditional investment analysis techniques and criteria, such as return on investment, net present value, or payback period could be used; but because of the unique nature of the IS investments, they seldom suffice in practice. Instead, the evaluation of success has to be supplemented by a subjective judgement and surrogate measures.

The reliability of the subjective success evaluation has been improved by the use of multi-item measurement scales. One of the best known of these scales is the user information satisfaction (UIS) which offers a standard measuring instrument for comparing the results across organizations, systems and measurement points [2, 13, 21]. Despite its obvious benefits, UIS has also been widely criticized [5, 10, 12, 16, 27]. The main criticism has been aimed at an inadequate definition of the key constructs, a poor theoretical base, and a narrow scope, making the validity of its contents debatable.

In this paper, the scope of UIS is extended to reflect the success of an IS investment more thoroughly. Besides the indirect success measures included in UIS—the quality of the IS product and related services—we develop measuring scales for the success of the development process (standing for the investment costs and efficient use of the

[1] Tel.: 358-9-43131; fax: 358-9-43138700; e-mail: saarinen@hkkk.fi

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resources) and the impact of the IS on the organizations (standing for the benefits of the investment). The reliability and validity of the resulting four measuring scales were tested with the data gathered from 48 recently completed IS development projects in Finnish companies.

Section 2 of this article discusses the approaches for success evaluation and proposes some extensions to the current UIS instrument. Development of the resulting four measuring scales is described in Section 3 and the methodology for the empirical survey in Section 4. Tests on the reliability and validity of the measuring scales are reported in Section 5 and finally, some conclusions are given in Section 6.

2. Measurement of success

2.1. Success evaluation approaches

The scope of the success measures as well as the approaches for the measurement vary a lot in the IS literature (see extensive reviews in [8, 15]). It has shown very problematic to find an acceptable dependent variable for IS studies, making comparison of the results and establishment of a cumulative tradition difficult.

Success has often been defined as a result or outcome, or a favorable or satisfactory result or outcome. How is then the result or outcome, in a case of an IS investment, be characterized? Is it the IS product itself or the net benefit of using it, or both? Furthermore, for whom should that result be favorable or satisfactory: the developers, the users of the IS, or the managers? Developers may aim at a high quality IS product at a minimum cost. Users' satisfaction may be determined by the ease of use and proper support of their own work. Managers, in turn, may prefer economic and quantitative values of both the costs and benefits, giving an opportunity to compare the IS investments with the alternative uses of the resources.

Many special features of IS investments make obtaining adequate measures of costs difficult, but are especially beneficial to managerial decision making. IS investments are in many ways comparable with investments in production equipment, but there is a strong element of organizational development as well. Furthermore, IS investments share many features with the research and development investments, often having corporate-wide, intangible and long lasting effects. Therefore, economic evaluation and quantitative measures tend to be difficult to obtain and easy to manipulate. They seldom suffice in practice, but should be supplemented with subjective judgment and multiple diversified criteria (for example, [1, 4]).

Subjective success evaluation and multi-item measuring scales have many advocates among the IS researchers [2, 13, 17]. User satisfaction is commonly accepted as a surrogate measure for the IS success, but it has been operationalized in many different ways. Miller [17] reviewed 12 different instruments for measuring user satisfaction. They vary in scope, but the main emphasis is on the IS product and services related to its use. The motivation for using user satisfaction as a dependent variable, lies in the assumed causal links between high quality information, better decision making and value of the organization.

The main distinction among the objectivity of different success measures does not seem to be a matter of using quantitative or financial figures as opposed to the users' and managers' perceptions. For example, the return on investment, net present value and payback period are often regarded as objective criteria. However, because of the many difficulties in predicting and assessing costs, and especially benefits, the investment analyses, if performed, are usually based on experts' judgment [23]. If the estimates are based on subjective predictions, to be changed many times during the project, their objectivity becomes questionable. Use of the quantitative and financial figures, based on subjective estimates does not make them more objective than the less quantitative criteria. In fact, in many cases, the subjective measures may be even better than the quantitative measures. For example, one might have a project with an estimated duration of 12 months and a realized duration of 14 months. Has the development process of this prepared project been a success or not? It depends: in some cases, for example, routine accounting systems, a two months delay may not matter much. In some other cases, for example, marketing systems with direct contacts to the customers, a two months delay may cause a disaster. The contextual effects on what is favorable or satisfactory may be very complicated. They are best handled by letting the managers—responsible for the object of evaluation—be the judge. In IS investments, situational factors have especially strong effects due to the nature of the investments. Therefore, in many cases, the subjective evaluation approach with multiple criteria is an appropriate way to assess IS investments.

2.2. *User information satisfaction*

One branch of user satisfaction studies has developed a standard measure, the user information satisfaction instrument (UIS) [2, 3, 13, 20]. Bailey and Pearson [2] defined user satisfaction as the sum of one's positive and negative reactions to a set of factors affecting the success of an information system. They constructed an instrument, consisting of 39 items and several adjective pairs for each item [2, 20]. Ives et al. [13] replicated the study, and refined the instrument by discarding many items and adjective pairs. They ended up in a short form standard UIS, consisting of 13 items and only two adjective pairs for each (see also [3]). They also modified the definition of UIS to the extent of the users' belief in the efficacy of the information system available to them in meeting their information requirements.

The development of UIS has been a very important and promising step towards better measures for the IS success. However, there are also several problems piled up in more critical literature as follows:

1. The validity of UIS as an indicator of the IS success is debatable. Baroudi and Orlikowski [3] received support for its reliability and validity, while Treacy [27], and Galetta and Lederer [10] criticized it for poor validity. Furthermore, Chismar et al. [5], Iivari [12], and Melone [16] have carried out theoretical evaluations of UIS as a measure of the IS success. They conclude that UIS is not grounded in any theory and it is questionable whether it covers all the essential features of the IS success. UIS, as it has been operationalized, can be seen as an indicator of the service; and quality of an IS measuring success, only indirectly. It does not directly measure such aspects of success as the impact of the IS on the organization or the effort needed to develop the system that are especially important to the management.
2. The items in the existing measuring scales are heterogenous (see also [10]). For example, summing items, concerning the quality of output information and feeling of participation, do not make much sense. If we accept that the IS success is not only a multi-item, but also a multi-dimensional construct, the idea of summing all the items to form a single scale is not acceptable (see also [16]). This technique would perhaps be effective in diagnosing total failures and successes, but information systems usually fall somewhere between these extremes; they succeed in some respect and perform averagely, or fail in some other respect. The nature of each situation cannot be assessed by a simplistic one-dimensional measure of success.
3. UIS does not take the modern IS environment properly into account [9]. The transition from an indirect batch-oriented use of the IS to a direct online use in computers has changed the way the users and managers produce and utilize information. User interface and flexibility of the system, to adapt according to changing user requirements, are omitted in the UIS instrument.
4. Measuring scales use such adjectives as "very well", "adequate", "marginal" and "poor". It is not fair to treat these scales as interval scales [10]. This has implications on the statistical methods that can be applied. Galetta and Lederer concluded that non-parametric statistical analyses should be used instead of parametric tests. The scales should be developed more carefully in this respect.

2.3. *Extensions of UIS*

When using the subjective evaluation approach, it is possible to assess many different objects of interest. Existing user satisfaction measures like UIS do not, however, cover all essential issues related to the success of an IS investment. Need for the success evaluation has expanded from the management of the development process to the assessment of user satisfaction along with the quality

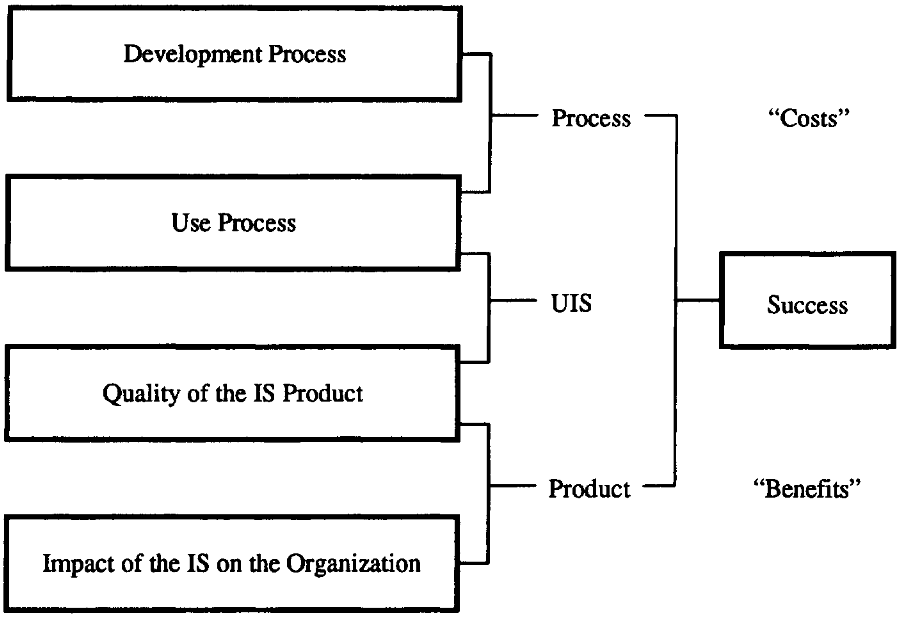

Fig. 1. Main dimensions of IS success.

of the information, system and related services. Recently, the impact of the system on the organization, utilizing this, has also been emphasized. In the early stages of computing, it was not usually so problematic, because the impacts were often realized in the form of clear cost savings due to automation of the manual systems. Today, information systems often change organizational structures and behavior, by facilitating inter-organizational communication and cooperation. UIS does not cover all these issues and it has to be expanded accordingly.

Firstly, the UIS measures the benefits, only indirectly. Therefore, apart from the users' attitudes and beliefs about the information system, a subjective evaluation procedure should also comprehend changes in the organization's structure and processes yielding to benefits of the organization. Delone and McLean [8] in their extensive review of different success measures, show that the UIS measures take neither individual nor organizational impacts into account. Secondly, success of the development process should also be considered as a criterion for the success of an IS investment [5]. This is justified, since the profitability of an IS investment depends on both the benefits and costs of the investment. A significant increase in costs automatically affects profitability. Minimizing schedule overrun is also important because it determines the time when the system starts to benefit the organization. Furthermore, if the development process is problematic, it may affect both the quality of the IS and the willingness of users to adopt it.

Now we are in a position to define a successful IS development project as follows (see also [5, 8, 17]): *The system development process leads to a high quality IS product whose use has a positive impact on the organization.*

Based on this definition, it is possible to treat success as a four-dimensional construct, consisting of the success of the development process, success of the use process, quality of the IS product, and impact of the IS on the organization (Figure 1). The two extensions (inclusion of the development process and impact of the IS on the organization in the success measure) align the subjective success evaluation better with the traditional cost–benefit paradigm, thereby increasing its content validity significantly. As the main dimensions of success give information about different aspects of success, they have to be measured separately.

2.3.1. Success of development process:

Successful development of an information system requires capable and motivated users and system analysts, who can effectively communicate and specify requirements for the system. System analysts must be able to design a system, meeting these requirements, and implement it into a technically feasible solution. Furthermore, the system analysts should be able to help the users in implementing the system into their environment. All this has to be done within a given time and budgetary constraints.

Measurement of the success of the development process can be based on an external view of the adherence to the given budget and time schedule [14]. In addition, the assessment of each stage of the development life-cycle may give a more detailed information on the success [11]. One way to measure the success of the development process is to use an internal view of the project, and evaluate if the most important prerequisites of the success, such as adequate level of developer and user expertise, have been present in the development process. This is the basic idea also in the UIS instrument [2, 13].

2.3.2. Success of use process

IS staff, giving the ongoing services related to the use of the system as well as users of the system, should have those attitudes and capabilities that would help them to communicate effectively and specify the users' service needs. The IS staff should be able to respond to these requests and give the services to the users without unnecessary delay.

Evaluation of the use process can be done by the outcomes of the IS services provided to the users. Since, IS services are often complex, it is important that both the users' and IS staff's abilities allow for communication and co-operation to specify the detailed service needs. This is assumed in the UIS instrument [2, 13], and it is supported by the theories of the efficient organization and delivery of different services [18, 28]. When one is not relying on the relationships between the IS staff and users, it is unlikely that the services provided to the users meet all their specific and complicated requirements.

2.3.3. Quality of the IS product

Measurement of the IS product quality is often based on the users' perceptions of different attributes of the system (for example, [2, 9, 13]). High quality IS products should have both high system quality and high information quality (see [8]). High system quality requires a good user interface and, in the long-run, flexibility, allowing changes in the processing styles, and adaptation to new requirements. A system having a high information quality should, in turn, provide users relevant and reliable information in the desired format.

2.3.4. Impact of IS on the organization

Use of an information system is a necessary condition for success. However, it should also yield to a positive impact on the organization, utilizing this. These changes should be measured in quantitative and monetary figures. However, as discussed earlier, they are often difficult to obtain. One possibility is to use surrogate measures, like the managers' perceptions of changes, but ensuring that they are asked to assess such changes that affect the profitability of the investment. Information systems can not only change the organization's structure, but also improve work processes, make decision making processes more effective and intensify the controls of the organization. Furthermore, they often improve communication, both inside the company, and between the company and its customers and suppliers.

In order to operationalize these ideas, we developed and tested the reliability and validity of the measuring scales for each of the four main constructs.

3. Development of measurement scales

3.1. Pilot study

In late 1987 and early 1988, we carried out a study, assessing the use of situational approaches in the IS development [22]. In that study, we collected a set of success measures used in earlier studies, reported in the IS literature. We used factor and cluster analysis techniques to construct a dependent variable for the study. It became evident that success is not a one-dimensional construct; a project can succeed in some respect and fail in another. For example, there were many projects in our sample that had considerably exceeded their time and budgetary constraints, but still produced very good results. We learned that

Table 1
Correlations between items measuring the success of the development process, corrected total of the development process scale and its control variables

Development process					Item to control variable correlations		
		Mean	Std. dev.	Item to total corr.	PMgr	LMgr	UIS
IS capabilities							
DP1	IS knowledge	4.89	1.57	0.57***	0.23	0.40***	0.29**
DP2	Business knowledge	4.47	1.61	0.52***	0.35***	0.48***	0.39***
DP3	Communication skills	4.74	1.54	0.51***	0.26**	0.51***	0.54***
DP4	Commitment	4.77	1.72	0.53***	0.17	0.54***	0.41***
User capabilities							
DP5	IS knowledge	4.02	1.47	0.32**	0.31**	0.25**	0.13
DP6	Business knowledge	5.69	1.34	0.32**	0.00	0.23*	0.36***
DP7	Communication skills	4.94	1.34	0.44***	0.20**	0.18	0.04
DP8	Users commitment	5.04	1.68	0.51***	0.38***	0.35***	0.30**
DP9	Management commitment	5.15	1.56	0.55***	0.33***	0.29**	0.29**
Development phases							
DP10	Requirement specifications	5.10	1.19	0.23**	0.46***	−0.08	−0.11
DP11	Analysis and design	5.10	0.99	0.30**	0.46***	0.22*	0.22*
DP12	Technical implementation	4.90	1.42	0.36***	0.60***	0.33***	0.32**
DP13	Installation and start up	5.08	1.18	0.39***	0.51***	0.36***	0.39***
Controllability							
DP14	Schedule	3.32	1.72	0.20*	0.38***	0.18*	0.05
DP15	Budget	3.39	1.35	.27**	0.24**	0.10*	−0.13
DP	Development process	4.70	0.74	-	0.66***	0.58***	0.47***

Significance levels: ***=0.01, **=0.05, *=0.10
Legend: PMgr=Project manager's perceived success of the development process; LMgr=Line manager's perceived success of the development; process; UIS=Short form of user information satisfaction (Ives et al. 1983; Baroudi and Orlikowski, 1988)

analyzing success as a multi-dimensional construct was fruitful, but we were rather critical of the detailed success measures we used.

3.2. Item generation

In response to the feedback from our pilot study, we went back to the literature and sought better measures for success. The main results of that search process are reported earlier in this article. UIS was found to be the most promising success measure, even though it clearly needed further development.

On the basis of the critique of UIS, we decided to extend it, to provide better coverage of essential issues involved in success. Items were generated for measuring each of the four constructs, introduced above: the development process, use process, IS product quality and impact of the IS on the organization. In the first stage of the analyses, we treated the development process as one construct, but the first empirical analyses showed that there was a considerable need to separate the development and use processes. The respondents did not see the development process, covering the use and maintenance phases of the life-cycle, as we initially believed. We thought that the development process was a continuous effort to keep the system in shape. The reason that the respondents separated the development and use processes so strongly might be that the people participating in these two processes were different; not all the users were involved in the development phases, and the system analysts who participated in the development process did not provide ongoing services related to the use of that system. Furthermore, perceptions of service are in many cases related to a set of applications and not to a single application. To avoid unnecessary details and confusion, we report here only the results of the final instrument.

Table 2
Correlations between items measuring the success of the use process, corrected total of the use process scale and its control variables

Use process					Item to control variable correlations			
		Mean	Std. dev.	Item to total corr.	PMgr1	PMgr2	LMgr	UIS
User knowledge and involvement								
UP1	Training	4.35	1.03	0.42***	0.39***	−0.06	0.07	0.39***
UP2	Knowledge	3.86	1.08	0.43***	0.54***	0.27**	0.21*	0.59***
UP3	Participation	4.72	1.06	0.32**	0.18*	0.06	0.11	0.41***
IS Staff								
UP4	Attitude	4.77	1.33	0.69***	0.32**	0.15	0.22*	0.66***
UP5	Relationships	5.16	1.22	0.66***	0.32**	0.08	0.30**	0.57***
UP6	Communication	4.72	1.19	0.77***	0.38***	0.19*	0.34***	0.70***
IS services								
UP7	Changes	3.29	1.10	0.59***	0.31**	0.21*	0.29**	0.66***
UP8	New requirements	3.72	1.33	0.61***	0.11	0.23*	0.23*	0.59***
UP	Use process	5.01	0.83	-	0.46***	0.21*	0.33***	0.84***

Significance levels: ***=0.01, **=0.05, *=0.10

Legend: PMgr1=Project manager's perceived success of the use process; PMgr2=Project manager's perceived success of the development process; LMgr=Line manager's perceived success of the development process; UIS=Short form of user information satisfaction (Ives et al. 1983; Baroudi and Orlikowski, 1988)

A detailed list of items was generated. They are listed in the first column in Tables 1–4. Items were generated for a study, intended to assess the success of a wide variety of information system development projects in large Finnish organizations [23]. We, therefore, wanted the measures to be general in nature. The impact items, in particular, could not be very specific, since they had to be appropriate in a variety of application areas. We wanted the items to address changes in all kinds of organizational processes, since large systems not only automate routine work processes, but also serve as communication tools and support decision makers in their work. They are seldom purely transaction processing or DSS applications, but combinations of them.

3.3. Control group feedback

The first attempt at an empirical assessment of the validity of the measuring instrument was made by employing the members of the advisory group of our research project as a control group. The group was established in cooperation with the Finnish Information Processing Association that consisted of six IS managers, line managers and IS experts.

First, we used a questionnaire, consisting of open questions, concerning the manner in which the respondents characterize successful and unsuccessful information systems. This information was interpreted and used for assessing whether our main constructs and detailed items were valid and representative.

The feedback was not conclusive. On one hand, the answers of the respondents easily fell within our main dimensions. On the other hand, there were certain items that were not mentioned in any of the answers: the detailed phases of the development process and the detailed organizational processes (except the work processes). The reason might be that open questions prevented the respondents from going into that level of detail.

The control group also commented on the detailed items included in the questionnaire and tried to improve them. Some of the questions were refined on the basis of this feedback. Finally, three selected members of the control group filled the whole questionnaires. The members participating in this activity were those who had recently implemented a new IS in their organization. After refining some details of the instrument, the advisory group approved the questionnaire.

Table 3
Correlations between items measuring the quality of the IS product, corrected total of the quality scale and its control variables

Quality of the product					Item to control variable correlations		
		Mean	Std. dev.	Item to total corr.	PMgr	LMgr	UIS
User interface							
Q1	Performance	4.79	1.40	0.65^{***}	0.25^{**}	0.30^{**}	0.61^{***}
Q2	Response times	4.54	1.49	0.64^{***}	0.21^{**}	0.37^{***}	0.49^{***}
Q3	User friendliness	5.08	1.35	0.64^{***}	0.41^{***}	0.39^{***}	0.56^{***}
Q4	Ease of use	4.96	1.25	0.44^{***}	0.20^{**}	0.32^{**}	0.33^{**}
Flexibility							
Q5	Changes	4.25	1.47	0.59^{***}	0.17	0.21^{**}	0.54^{***}
Q6	New requirements	4.33	1.51	0.45^{***}	$.23^{*}$	0.19^{*}	0.37^{***}
Information quality							
Q7	Precision	5.38	1.45	0.59^{***}	0.30^{**}	0.44^{***}	0.55^{***}
Q8	Accuracy	5.31	1.34	0.50^{***}	0.32^{**}	0.54^{***}	0.59^{***}
Q9	Reliability	5.38	1.23	0.68^{***}	0.35^{***}	0.56^{***}	0.69^{***}
Information contents							
Q10	Completeness	5.46	0.97	0.49^{***}	−0.01	0.16	0.34^{***}
Q11	Relevancy	5.12	1.04	0.70^{***}	0.38^{***}	0.48^{***}	0.56^{***}
Q12	Timeliness	5.02	1.45	0.73^{***}	0.23^{*}	0.41^{***}	0.58^{***}
Q13	Up-to-datedness	5.15	1.41	0.66^{***}	0.15	0.40^{***}	0.56^{***}
Information format							
Q14	Format	5.17	1.02	0.32^{**}	0.13	0.20^{*}	0.27^{**}
Q15	Clarity	5.25	0.96	0.51^{***}	0.24^{**}	0.28^{**}	0.41^{***}
Q	Quality of the IS product	4.32	0.80	-	0.37^{***}	0.55^{***}	0.78^{***}

Significance levels: ***=0.01, **=0.05, *=0.10
Legend: PMgr=Project manager's perceived success of the quality of the IS product; LMgr=Line manager's perceived success of the quality of the IS product; UIS=Short form of user information satisfaction (Ives et al. 1983; Baroudi and Orlikowski, 1988)

Based on the above findings, we believe that content validity received some support. The answers were easily interpreted via our instrument and most of the detailed items were mentioned even in this small sample. The control group helped us also to refine the questionnaires to a level that was satisfactory to them. However, further attempts to analyze the validity are clearly needed.

4. Survey

4.1. Methodology

The next step in the development of the measuring instrument was a mail survey for testing the four scales. The most important stakeholders, included in the study, were project managers, who assessed the success of the development process and the users' capabilities; and line managers, who assessed the IS staff's capabilities, controllability of the development processes and results, i.e. the quality of the information system and its organizational impact.

In order to validate our measuring instrument, we used line managers' and project managers' perception of success for the three initial constructs in our model: the development process, the quality of the IS product and its impact on the organization. Since, the development process was divided into development and use processes, the estimates of the project managers concerning the success of the use phase served as a criterion for the use process. We also used a slightly modified version of the short-form UIS [3, 13], as a criterion for all the four constructs. The items included in this control variable were the same as in the short-form UIS instrument, although we used only one question for each item. This control variable includes same items as success

Table 4
Correlations between items measuring the impact of IS on the organization, corrected total of the impact scale and its control variables

Impact of the IS on the organization					Item to control variable correlations		
		Mean	Std. dev.	Item to total corr.	PMgr	Lmgr	UIS
Use and changes							
I1	Extent of use	5.44	1.15	0.24**	0.38***	0.35***	0.28**
I2	Improvements	4.65	1.04	0.69***	0.53***	0.54***	0.50***
Efficiency and profitability							
I3	Profitability	3.92	1.18	0.67***	0.14	0.52***	0.38***
I4	Price/performance	4.77	1.29	0.34***	0.38***	0.42***	0.60***
I5	Work processes	5.31	1.17	0.57***	0.28**	0.41***	0.45***
I6	Cost savings	3.54	1.68	0.51***	0.32**	0.46***	0.48***
I7	Efficiency	5.17	0.95	0.58***	0.34***	0.53***	0.57***
Decision making and control							
I8	Decision making	4.25	1.34	0.52***	0.32**	0.32**	0.22*
I9	Control	4.31	1.53	0.49***	0.35***	0.32**	0.19*
I10	Effectiveness	4.77	1.43	0.54***	0.51***	0.53***	0.38***
Communication and reorganization							
I11	Internal communication	4.73	1.20	0.66***	0.48***	0.53***	0.23*
I12	Inter-organizational communication	3.85	1.58	0.52***	0.18	0.47***	0.13
I13	Organization structure	2.88	1.48	0.23*	0.00	0.20*	−0.01
I14	Data processing	4.37	1.30	0.63***	0.14	0.37***	0.36***
I	Impact of the IS on the organization	4.42	0.78	-	0.51***	0.77***	0.51***

Significance levels: ***=0.01, **=0.05, *=0.10)
Legend: PMgr=Project manager's perceived success of the impact of the IS; LMgr = Line manager's perceived success of the impact of the IS; UIS = Short form of user information satisfaction (Ives et al. 1983; Baroudi and Orlikowski, 1988)

of the use process and IS product quality scales. Therefore, it is more relevant to compare it with the success of the development process and impact of the IS on the organization scales.

All the scales, used in our study, were developed to overcome the difficulties of seeing them as ordinal scales. We used seven point scales, where only the extreme points of each scale were labeled. Increments in the scales can thus be regarded as equal. This technique makes the scales more like interval scales and provides more justification for the use of parametric statistical analyses.

All the four scales, success of the development process, success of the use process, IS product quality, and impact of the IS on the organization, were constructed in a similar way. The average of items, in each of the main groups of variables, was computed and used to construct the scales for each dimension. This was necessary because we had different numbers of variables in each variable group, but we wanted them to contribute to the scales with equal weights.

4.2. Data collection

The data were collected from the 200 largest companies and 25 largest banks and insurance companies in Finland [23]. Altogether 272 IS managers from these organizations were contacted using mail and asked to contribute to our study (some companies have an IS manager for each business unit). One short questionnaire sent to the IS managers asked for a list of all projects, finished in the last two years, with a brief evaluation of their success. We asked the IS managers to name the two most recently implemented information systems for our review, and asked them to name the project manager and line manager responsible for the system, so that we could send another, more detailed questionnaire to them.

Within one month, 102 IS managers returned the first questionnaire. However, 47 of them were either not able to nor willing to participate in the second part of the study. The main reasons were: they had no new information systems implemented in the last two years, the company had been recently reorganized, and the IS manager had either been recently nominated or was too busy to participate in the study. The remaining 55 companies form a representative sample of the population in terms of the industry and size of the company. The IS managers in these companies evaluated the overall success of 247 information systems. They also indicated 101 most recently implemented systems for our detailed analyses (some organizations had not implemented two system in the last two years). Furthermore, they gave us the names of the project and line managers of these systems and, later on, we received responses to the detailed questionnaires from 70 project managers and 62 line managers.

These response rates were achieved by reminder letters and several telephone calls. Altogether, we have 48 responses containing evaluations from both the project and line managers, forming the database used in our analyses in this article. Detailed tests of these projects indicated that we have a representative sample of 247 projects completed in large Finnish companies with regard to type of the system, application area, and overall level of success assessed by the IS managers [23]. However, based on these tests, we can not say anything about the representativeness of the sample regarding any other factors.

4.3. Profile of the participating companies and the information systems

The average net sales of the companies studied was FIM 1906 million per year (FIM 1=USD 0.25), and the average employment, 2317. More than 60% of the companies were manufacturing; about 20% were retail and wholesale companies. Less than 10% of the companies came from banking or insurance, and the rest from the service sector.

The average budget of the information systems studied was FIM 1.2 million, the average duration of the development project, 17 months, and the average of the total effort, 41 man months. More than 30% of the systems, included in the detailed analyses, were for accounting, and more than 30% for marketing. About 20% of the systems supported manufacturing activities, and the rest of the systems, business administration or purchasing. In general, the systems were rather ordinary business information systems in large companies.

5. Tests of the measuring scales

In this study, we aim at a multi-dimensional measurement instrument for the success of an IS investment. Therefore, the reliability and validity, for each of the four main constructs we have developed, are assessed separately [6].

5.1. Reliability

The reliability of a measure reflects high internal consistency, i.e. the detailed items (questions) measure the same thing. In this study, the reliability of the constructs was assessed using Cronbach's alpha reliability coefficient [7], suggested by Peters [21] for multi-item scales.

Cronbach's alpha for the development process variables was 0.80, for the use process variables, 0.83, for the quality of the IS product variables, 0.89, and for the impact variables, 0.85. All these coefficients are at least 0.80, regarded as sufficient for basic research [19]. The reliability of the developed scales is, thus, not a problem, at least not in this sample.

5.2. Content validity

Content validity means we measure what we are supposed to measure. In other words, if we aim at a good measure of information systems success we should be convinced that the measurement instrument includes the essential features of success (see [6]). According to Nunnally [19], content validity can be best assured by the procedures used to develop measures. We tried to achieve a high content validity by a two-phased research strategy which helped us in understanding the phenomena of IS success. We also tried to connect success measurement with the traditional cost–benefit paradigm, widely accepted by managers. Furthermore, we used a control group to provide feedback and develop our ideas. The control group also pretested our questionnaires.

The above means clearly increased the content validity, but were still not adequate. Therefore, content validity was studied further in the survey phase by analyzing correlations between the control variables for each construct and the detailed items measuring that construct. We tried to identify items that had low correlations with the control variables and were not measuring what they were supposed to measure. The item to control variable correlations are shown in Tables 1–4, for each of the four constructs.

The highest correlations between the control variables for the development process and detailed items in the final instrument varied in the range 0.20–60 and they were all significant, at least, at the 0.10 level, and the most, at the 0.01 level. The range for the correlations of the use process is 0.39–0.70, all significant at the 0.01 level. The highest correlations for the quality of IS varied in the range 0.27–0.69, and they were significant at least at the 0.05 level. The range for the impact variables was 0.20–0.60, all significant, at least, at the 0.10 level.

On the basis of the item to control variable correlations, the questionnaire could be improved by dropping some of the items. However, in this study we aim to test the measuring instrument, not to shorten it maximally; and since all the highest item to control variable correlations were significant, at least, at the 0.10 level, we did not drop any item from the instrument. These results indicate that the content validity of each of the four constructs is sufficient. However, it could and, in fact, should be studied further, for example, using critical incidents' analysis as Bailey and Pearson [2] did and by replicating the study in other contexts.

5.3. Predictive validity

Predictive validity in our case means that the measuring instrument distinguishes the successful cases from the unsuccessful ones, and converges with other alternative measures of success. High correlations reflect high predictive validity. However, if they are very high, it may also mean that the new scales provide the same information as the existing ones and may, therefore, be redundant. Correlations between the developed scales and control variables were used to study the predictive power of each construct.

Correlations between the development process scale and its control variables—success of the development process as perceived by project managers, success of the development process as perceived by line managers, and UIS—are 0.66, 0.58 and 0.47, respectively (Table 1). Correlations between the use process scale and its control variables—success of the use phase as perceived by project managers, success of the development process as perceived by project managers, success of the development process as perceived by the line managers, and UIS—are 0.46, 0.21, 0.33 and 0.84, respectively (Table 2). Correlations between the quality of the IS scale and its control variables—quality of the IS as perceived by project managers, quality of the IS as perceived by line managers, and UIS—are 0.37, 0.55, and 0.78, respectively (Table 3). Finally, correlations between the impact scale and its control variables—impact of the IS on the organization as perceived by project managers, impact of the IS on the organization as perceived by line managers, and UIS—are 0.51, 0.77, and 0.51, respectively (Table 4). All correlations, except the one between the use process scale and success of the development process as perceived by project managers, are quite high and significant at the 0.01 level, thereby showing a high predictive validity. A very high correlation between the use process and quality of IS scales, and UIS are, at least, partially explained by the fact that UIS contains IS services and information quality.

5.4. Construct validity

Construct validity, in this case, means that the underlying structure of the developed construct is found also in reality. This can be analyzed first, by correlating with the detailed items and scale. However, a more powerful method for analyzing the construct validity is factor analysis. In this study, we used both techniques. Corrected item to total correlations, for the development process scale, vary in the range 0.20–0.57 (Table 1). They are all significant at the 0.10 level. Corrected item to total correlations, for the use process scale, vary in the

Table 5
The four factor varimax solution of the development process variables

Development process		Factors 1 IS capabilities	2 User capabilities	3 Development phases	4 Controllability
IS capabilities					
DP1	IS knowledge	0.82	0.15	0.09	0.10
DP2	Business knowledge	0.84	0.03	0.11	0.11
DP3	Communication skills	0.86	0.18	−0.01	−0.06
DP4	Commitment	0.83	0.07	0.12	0.08
User Capabilities					
DP5	IS knowledge	−0.02	0.78	−0.09	0.15
DP6	Business knowledge	0.28	0.59	0.00	−0.38
DP7	Communication skills	0.09	0.83	−0.05	0.12
DP8	Users commitment	0.17	0.63	0.48	−0.24
DP9	Management commitment	0.23	0.64	0.36	−0.05
Development Phases					
DP10	Requirement specification	−0.37	0.38	0.53	0.36
DP11	Analysis and design	−0.16	0.07	0.69	0.42
DP12	Technical implementation	0.14	−0.01	0.79	0.04
DP13	Installation and start up	0.29	−0.02	0.73	−0.11
Controllability					
DP14	Schedule	0.11	−0.03	.06	0.88
DP15	Budget	0.16	.05	.04	0.82
Eigen value		4.16	2.52	2.19	1.59
Percentage of variance explained		27.7	16.8	14.6	10.6

range 0.32–0.77 (Table 2), and for the quality of IS scale, in the range 0.32–0.70 (Table 3); all being significant at the 0.05 level. Corrected item to total correlations, for the impact scale, range 0.23–0.69 (Table 4) and they are all significant at least at the 0.10 level. According to item to total correlations, the construct validity of the scales is satisfactory, but not extremely high.

Table 5 shows a four-factor solution for the development process dimension. The analyses were carried out using principal components analysis and varimax rotation. The first factor is labeled IS capabilities, the second factor user capabilities, the third factor development phases, and the fourth factor controllability. The factor solution illustrates rather a good construct validity of the development process scale.

Table 6 shows the three-factor solution of the use process dimension. The first factor is labeled IS staff, the second, user's knowledge, and the third, IS services. Except for users' feeling of participation which seems to cause some problems, the factor solution turned out as expected. Users' feeling of participation did not load the same factor with the users' knowledge and training, provided to the users. It loaded the same factor with the IS services. This indicates that the user participation does not adequately measure the users' abilities, but is instead connected to the receiving responsive IS services. Extensive training and increased knowledge may be the prerequisites for participation which is a good means to make the IS staff aware of the users' requirements, facilitates the acquisition of the service when needed. Factor analysis shows that a feeling of participation has a low construct validity and should be used with caution in the UIS scales. However, we did not eliminate it in this study, since it caused no further problem in other areas of reliability and

Table 6
The three factor varimax solution of the use process variables

Use process		Factors 1 IS staff	2 Users' knowledge	3 IS services
User knowledge and involvement				
UP1	Training	0.15	0.86	0.04
UP2	Knowledge	0.11	0.84	0.13
UP3	Participation	0.17	−0.16	0.75
IS staff				
UP4	Attitude	0.92	0.08	0.21
UP5	Relationships	0.90	0.12	0.14
UP6	Communication	0.84	0.22	0.28
IS services				
UP7	Changes	0.15	0.45	0.70
UP8	New requirements	0.30	0.30	0.70
Eigenvalue		3.80	1.38	0.97
Percentage of variance explained		47.5	17.3	12.2

Table 7
The five factor varimax solution of the IS quality variables

Quality of the IS product		Factors 1 Information quality	2 User interface	3 Information contents	4 Informamation format	5 Flexibility
User interface						
Q1	Performance	0.42	0.64	0.04	0.37	0.11
Q2	Response times	0.40	0.72	0.17	0.12	0.04
Q3	User friendliness	0.04	0.84	0.27	0.05	0.24
Q4	Ease of use	−0.07	0.87	0.12	0.08	0.02
Flexibility						
Q5	Changes	0.29	0.07	0.20	0.21	0.82
Q6	New requirements	0.00	0.17	0.16	0.10	0.90
Information quality						
Q7	Precision	0.85	0.08	0.31	0.04	0.04
Q8	Accuracy	0.93	0.10	0.06	−0.00	0.05
Q9	Reliability	0.85	0.13	0.29	−0.00	0.23
Information contents						
Q10	Completeness	0.08	0.02	0.79	0.26	0.07
Q11	Relevancy	0.30	0.40	0.54	0.17	0.21
Q12	Timeliness	0.37	0.22	0.77	−0.00	0.26
Q13	Freshness	0.20	0.29	0.76	0.11	0.12
Information format						
Q14	Format	−0.07	0.05	0.18	0.90	0.11
Q15	Clearness	0.10	0.25	0.16	0.82	0.15
Eigen value		6.36	2.05	1.51	1.11	1.07
Percentage of variance explained		42.4	13.7	10.1	7.4	7.1

Table 8
The four factor varimax solution of the impact variables

Impact of the is on the organization		Factors 1 Decision making and control	2 Efficiency and profitability	3 Use and changes	4 Communication and reorganization
Use and changes					
I1	Extent of use	−0.05	0.00	0.82	−0.01
I2	Improvements	0.46	0.26	0.65	0.15
Efficiency and profitability					
I3	Profitability	0.43	0.73	−0.02	0.22
I4	Price/performance	−0.17	0.52	0.22	0.28
I5	Work processes	0.25	0.56	0.50	−0.01
I6	Cost savings	0.17	0.76	0.05	0.13
I7	Efficiency	0.09	0.59	0.62	0.01
Decision making and control					
I8	Decision making	0.83	0.18	0.00	0.10
I9	Control	0.85	0.03	0.09	0.12
I10	Effectiveness	0.59	0.26	0.44	−0.08
Communication and reorganization					
I11	Internal communic.	0.45	0.05	0.52	0.50
I12	Inter-org. communic.	0.20	0.22	0.09	0.79
I13	Organization structure	−0.06	0.06	−0.09	0.85
I14	Data processing	0.37	0.39	0.10	0.52
Eigen value		5.35	1.74	1.44	1.06
Percentage of variance explained		38.3	12.5	10.4	7.6

validity, and we were able to interpret the factor solution appropriately.

Table 7 shows the five-factor solution for the quality of the IS product dimension. The five factors illustrate high construct validity; no item loaded across the factors and the factor solution is rather as expected. User interface and flexibility loaded separate factors and information attributes on three distinct factors; information content, quality and format.

Table 8 shows the four-factor solution of the impact dimension. The factors were labeled decision making and control, efficiency and profitability, use and changes and communication and restructuring. It is noteworthy that both profitability and efficiency loaded the same factor. This indicates that profitability is still mostly related to the impact on the work processes and consequent cost savings. It was also interesting to discover that the improved communication and organization's structure loaded the same factor. In spite of the above findings, the results are in relatively good accordance with our expectations and the construct validity of the impact scale also received sufficient support.

6. Conclusions

There are no generally acceptable measures available to quantitatively and objectively assess an information systems' success. Researchers have, therefore, developed surrogate measures based on subjective evaluation approaches. The reliability of these measurement instruments have been increased using multi-item questionnaires. The user information satisfaction (UIS, [2, 13]) instrument has become widely accepted for evaluating the IS investments, even though it has been criticized because its validity is debatable.

In this study we extended the scope of UIS. While the UIS questionnaire includes only indirect measures of success—the use process and quality of the IS product—our approach measures success directly by success of the development process (standing for the investment costs and efficient use of resources) and impact of IS on the organization (standing for the benefits of the investment). A detailed list of items for each of the four dimensions was developed and the reliability and validity of the scales were tested among 48 recently completed IS development projects in major Finnish companies.

We have found a measuring instrument that can provide more effective dependent variables for IS studies (see for preliminary experiences in [24, 25, 26]). However, further research is needed, especially on its content validity. The instrument should also be tested in other environments so as to assure its general validity. Detailed items could be elaborated and whenever possible, more objective and quantitative criteria ought to be included in the instrument. We hope, however, that our results, already in their present form, contribute to a better measurement and management of the IS development projects as organizational investments.

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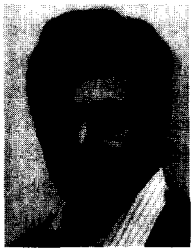

Timo Saarinen is an Associate Professor of Information Systems Science at the Helsinki School of Economics. He received his Ph.D. in 1993 in information systems. His research interests include the economics and management of information systems with an emphasis on the organization, marketing and logistics applications; competitive evaluation and risk management of systems development. He has published articles in *Information and Management, Journal of Management Information Systems, European Journal of Information Systems, Behavior and Information Technology, Journal of Systems Management,* and *Scandinavian Journal of Information Systems.*