MEASURING CRITICAL SUCCESS FACTORS IN ERP PROJECTS
Results from a Case Study in a SME

Jos J.M. Trienekens

Eindhoven University of Technology, Den Dolech 2, Eindhoven, The Netherlands

Pedro van Grinsven

RIS Rotterdam, Brugge 24, 2993 LB Barendrecht, The Netherlands

Keywords: ERP system implementation, success factors, measurement.

Abstract: Over the past decade many organizations are increasingly concerned with the implementation of Enterprise Resource Planning (ERP) systems. This counts for both large and small and medium sized companies. Implementation can be considered to be a process of change influenced by different so-called critical success factors (CSF) of type organizational, technological and human. This paper reports on the development of a measurement approach for managing CSF in an ERP implementation project in a small and medium sized company (SME). Critical success factors are being derived from project goals and subsequently measured in this project to monitor and control the implementation project.

1 INTRODUCTION

Over the past decades a new class of software applications has emerged: Enterprise Resource Planning (ERP) systems. These software packages seek to integrate the complete range of a business's processes and data communication patterns on the basis of one single information and IT architecture (Klaus et al, 2000). Quality control and assurance during the implementation of ERP packaged software has been under-researched, in particular regarding the identification, definition and validation of critical success factors (CSF) (Krumbholz and Maiden, 2001), (Marble, 2003). These factors can be of different types, such as organizational (e.g. top management support), human (e.g. communication attitude, user resistance), technical (e.g. business process modeling methods and tools), (Stelzer and Mellis, 1998), (Trienekens et al, 2001). Although some articles recognize factors that drive success in ERP implementation, they look at them from different perspectives and also with different definitions of "success factors" in mind (Aladwani, 2001), (Amoako-Gyampa and Salam, 2003). Over the past years several research papers have emerged that strive at the identification and classification of

CSF (Hoon Nah and Shang Lau, 2001). More recently research papers have emerged that focus on the evaluation and validation of CFS relevance in practice, e.g. the CFS relevance along the different ERP implementation project phases (Esteves and Pastor, 2004). This paper strives at taking one step further: the development of an approach towards measuring CSF during an ERP implementation project.

The ERP implementation project that has been selected is a current project at a small and medium sized (SME) enterprise, called RIS BV in The Netherlands. RIS BV is primarily active in the domain of innovative Traffic Sign Systems. Both standard products and tailormade systems, i.e. special projects, are being developed. One of their most important customers is the Dutch ANWB (national traffic organisation) for that they are the first supplier of route and road signs systems along the Dutch highways. The development process for these complex projects consists of analysis and design, manufacturing and implementation. These processes ask for integration of business data from different perspectives, e.g. project, financial, supply etc. An ERP system should support the flow of data throughout the company and the usage of a central

database concept, so that all involved departments can exchange information and communicate in an efficient and effective way.

RIS BV implements the ERP system Navision in its business processes. This is carried out in a modular way. The module that is being implemented currently is the Projects module. The high priority for implementing this module is a consequence of the current project planning problems at RIS. The traditional way of planning by using manually controlled Gantt charts (e.g. in Excel) is not effective anymore due to, among others, the high number of change requests in the complex projects.

On the short term RIS BVwants to improve their reliability and customer satisfaction regarding the finalisation of the complex projects in due time. The Navision Projects module should offer the opportunity to analyse and control the change requests in the planning process. On that basis it should become possible, in a flexible way, to derive management reports on the financial consequences of changes in the project.

In section 2 the research framework and approach is presented that is applied in the case study. Section 3 reports on the results of the case study at RIS BV. In section 4 conclusions and recommendations for further research are given.

2 RESEARCH FRAMEWORK AND APPROACH

Critical success factors (CSF) have become a management instrument in the broad area of software engineering, both in development and implementation. However, the applications that are presented in literature are still of a qualitative nature and do not support implementation managers in practice with operational and quantitative instruments. As a consequence most implementation projects only get little support from these studies. Therefore the main questions still are:
1. How to control ERP implementation projects in SMEs on the basis of CSF?
2. Can CSF be measured during implementation projects in SMEs?

Regarding the management and control of CSF several attempts have been made to make CSF operational, e.g. by elaborating the definitions and by investigating the usefulness of these definitions for practitioners. Although interesting results have been gained, previous research focused in particular on the possibility of applying CSF during ERP

implementation. E.g. in (Esteves et al, 2003) in particular two CSF are being investigated and only some attempts have been made to make these CSF operational. However experiences with measurement of CSF in real-life ERP implementation projects in SME is not yet reported.

Based on previous research findings on ERP implementation it was decided to make use of the set of CSF definitions of (Esteves and Pastor, 2000) and the GQM method (van Solingen and Berghout, 1999). Applying GQM in order to determine metrics has also been studied by (Esteves and Pastor, 2003). However the experimentation with GQM to monitor and control CSF in a real-life ERP implementation project has not yet been reported. Regarding the usage of CSF it was decided to select already early in the implementation project a limited set of CSF. This is in conformance with guidelines for the usage of metrics in real-life projects, (Kitchenham, 1996).

The ERP implementation project is relatively small, i.e. restricted to only one ERP module, a time interval of only three months, and to only 10 participating people. The approach that has been followed in our research consists of the following steps:
1. Development of the research framework: CSF and GQM
2. Applying the GQM approach in a real-life SME project:
    a. Identification of the goals of the project
    b. Selection of a limited number of CSF
    c. Development of the measurement instrument (i.e. questionnaires)
    d. Collection of the data
    e. Analysis and evaluation of the data
3. Evaluation of the research framework and approach

2.1 Critical Success Factors and Goal Question Metric Method

CSF have already been investigated by a number of researchers, see the introduction of this paper. In this paper the relatively recent and extensively researched list of (Esteves and Pastor, 2000) has been used, see table 1.

Table 1: CSF in accordance with (Esteves and Pastor, 2000).

CSF	
Sustained management support	Project champion role
Effective change management	Tactical adequate training program
Project scope management	Appropriate usage of consultants
Dedicated staff and consultants	Empowered decision makers
Communication	Organizational trust between partners
Formalised project plan	Strategic avoid customization
Project team composition	Technological software configuration
Comprehensive process reengineering	Legacy systems knowledge
Preventive trouble shooting	Adequate ERP version
ERP implementation strategy	User involvement and participation

The Goals Question Metrics (GQM) method is an operational instrument for the development of a metrics program (Solingen and Berghout, 1999). In accordance with GQM the goals, e.g. project goals, have to be stated first in a formalised way. Subsequently these goals have to be refined by questions about how these goals should be reached.

This refinement then leads to the identification of data that are needed. For the collection of these data operational metrics have to be defined. The GQM method as applied in our case study consists of four phases, respectively:

1: Planning the measurement – identifying project goals and allocating resources
In this phase the project goals are being defined in close collaboration with the project management and the overall management of RIS BV. Managers, project members, quality assurance employees involved in the implementation project have been determined and have been allocated to the measurement approach, e.g. regarding data collection, analysis and evaluation, and the development of improvement actions during the ERP implementation project.
2: Development of the measurement instrument
On the basis of a refinement of the project goals the relevant CSF that should be monitored and controlled have to be identified. Subsequently the data to be collected and analysed, in order to be able to evaluate the control on the project, have to be determined. In fact a measurement instrument for the collection of these data has to be developed.

3: Collecting the data – applying the questionnaires
In these phase the data have to be collected. Questionnaires have to be filled in by the stakeholders involved in the implementation project. Important is the distribution of the questionnaires, the organisation of information sessions to clarify the goals, and the analysis and feed-back of the measurement activities.
4: Evaluation of the data
The data has to be analysed in a predefined way, e.g. by using acceptation levels for the final scores. Acceptable measurement scales should be defined in close cooperation with representative stakeholders in the implementation project.

The combination of CSF with the GQM method has resulted in a measurement approach that has been applied in the ERP implementation project.

3 APPLYING THE MEASUREMENT APPROACH: CASE STUDY RESULTS

In this section the results of the case study on measuring CSF during ERP system implementation are presented. In the following we will first introduce in section 3.1 briefly the case study environment. Subsequently we will present the results of the application of the measurement approach.

3.1 Case Study at RIS BV

The case study has been carried out during the first three months of the implementation project in 2007. The objective was to experiment with questionnaire-based metrics in a real-life ERP implementation project and to make a first step towards a well-monitored and controlled project.

3.1.1 Identification of Project Goals

The goals of the ERP implementation project have been investigated and discussed with representatives from the various involved management levels and potential key users of the Navision application. Both the strategic goals of the organisation and the local objectives of the different involved departments have been taken into account. As main result the following project goals for the ERP implementation project have been defined:
- timeliness of finishing the implementation

- ability of key-users to make use of the ERP application immediately after implementation

3.1.2 Determination of CSF

Based on the two project goals the list of CSF has been discussed with the involved stake-holders. In particular a people dimension and a project dimension have been identified. This is in conformance with findings of (Estevez and Pastor, 2000) who identified also the importance of monitoring and controling in particular human and project aspects during an ERP implementation project. From each of the two dimensions several concerns of the involved stakeholders have been identified. Regarding the people dimension these concerns are respectively the CSF 'User-involvement and participation', and 'Tactical adequate training program'. Regarding the project dimension in particular the CSF 'Project champion role' and 'Dedicated staff and consultants' were identified.

3.1.3 Measuring CSF:The Questionnaires

For each of the determined CSF a small number of questions have been formulated with the involved stake-holders in order to be able to determine whether a CSF is under control or not. Regarding these questions structured answers, i.e. measurement scales, have been defined. The set of CSF with the questions and the measurement scales are forming together the measurement instrument. Regarding the formulation of questions we explicitly adopted similar questions as presented in the research of (Mendoza et al, 2006) In that way we were able to make a comparison between the results of our case study and the results of case studies of the previously mentioned authors. In the following the four questionnaires for the distinct CSF are presented.

Table 2: Questionnaire regarding the CSF Project champion role.

CSF	Relevance and motivation	
Project champion role	The project champion should have the capabilities to monitor and control the progress of the project and to take and communicate adequate decisions.	
	Questions	Scale
	Is the progress of the project under control?	5 = Always 4 = Almost always 3 = Sometimes 2 = Almost never 1 = Never

Table 2: Questionnaire regarding the CSF Project champion role. (cont.)

	Questions	Scale
	Are the decisions being communicated during project meetings?	5 = Very fast 4 = Fast 3 = Average 2 = Slow 1 = Very slow

Table 3: Questionnaire regarding the CSF Tactical adequate training program.

CSF	Relevance and motivation of the CSF	
Tactical adequate training program	A training and educational plan is needed to prepare the management and other stakeholders in the usage of the ERP application.	
	Questions	Scale
	Is a training and educational program available?	5=yes 1=no
	Is there sufficient time available for the training program?	5 = Plenty 4 = Sufficient 3 = Average 2 = Little 1 = Very little

Table 4: Questionnaire regarding the CSF User involvement and participation.

CSF	Relevance and motivation of the CSF	
User involvement and participation	To ensure the integration of the ERP application in the business system, both on the operational process level and on the management level, representatives from these levels should be involved in the implementation project.	
	Questions	Scale
	Is there a structured plan for the meetings and information sessions?	5 = Yes 1 = No
	Are the invited representatives present at the meetings and interview sessions?	5 = Always present (80–100%) 4 = Almost always present (60–80%) 3 = Average present (40–60%) 2 = Almost never present (20–40%) 1 = Never (0-20%)
	Are actions regarding 'not showing up' at meetings and interviews being executed in-time by the responsible persons?	5 = Always 4 = Almost always 3 = Sometimes 2 = Almost never 1 = Never

Table 5: Questionnaire regarding the CSF Dedicated staff and consultants.

CSF	Relevance and motivation of the CSF	
Dedicated staff and consultants	Technical support from the ERP provider is needed during the whole implementation project.	
	Questions	Scale
	How dependend is the implementation project from technical support?	5 = Very low 4 = Low 3 = Average 2 = High 1 = Very high
	Is technical support specified in the service level agreement in sufficient detail?	5 = Yes 1 = No

3.1.4 Data Collection and Analysis

In the first three months of the ERP implementation project the questionnaires have been filled in by 10 stakeholders from different organizational levels, respectively end-users, and managers on the tactical and the operational level. The results are shown in Table 6.

Table 6: Measurement results CSF.

CSF's, questions and total score per CSF	1: Acceptation level	2: Average	2 minus 1	Score in % of max.
Project champion role				
Q1	3	3,1	0,1	62
Q2	3	3,4	0,4	68
Total score				65
Tactical adequate training program				
Q1	5	1,0	-4	20
Q2	3	1,4	-1,6	28
Total score				24
User involvement and participation				
Q1	5	1,0	-4	20
Q2	3	4,5	1,5	90
Q3	3	4,5	1,5	55
Total score				55
Dedicated staff and consultants				
Q1	3	1,6	-1,4	32
Q2	5	5,0	0	100
Total score				66

For each of the CSF a total score has been calculated in a similar way as has been done in (Mendoza et al, 2006). The score of each question is presented as a percentage of the maximum that could be reached on the measurement scale. In Figure 1 the measurement results are presented and are compared with the measurement results of two previous ERP implementation project in organizations A en B (Mendoza et al, 2006

The 'Project champion role' is carried out satisfactory. However, 'Tactical adequate trainign program' scored significantly lower in the RIS implementation project than the reference organizations A and B. It appeared that 'Tactical adequate training program' is not well communicated throughout the organisation and that the training plan is not yet fully operational. As correcting action the development of a communication plan has been defined.
Regarding 'User Involvement and Participation' and 'Dedicated staff and consultants' several weaknesses have been identified, however the overall scores for these CSF are sufficient.

4 CONCLUSIONS

This paper shows that literature on CSF can act as a reference basis for the development of a measurement approach to monitor CSF in ERP implementation projects. The case study shows that a well-defined selection of CSF, derived from project goals, can be taken as a starting point for the development of a questionnaire-based measurement instrument. The relatively small questionnaire could be applied succesfully in a SME in practice during an ERP implementation project.

The (intermediate) results of the measurement are being used by the project management to monitor the implementation project and to take adequate actions. Further the (intermediate) results could be compared with results from other implementation projects that have been described in literature. As such a first step has been made towards benchmarking CSF measurement in ERP-implementation projects.

Further research is needed regarding the interrelationships between the explicitly defined project goals, the selected CSF and the questions (and measurement scales) of the measurement approach. Currently the measurement approach is applied in subsequent phases of the mentioned ERP implementation project. The results will be used to further improve the monitoring of the implementation project as well as the validation and further improvement of the measurement approach.
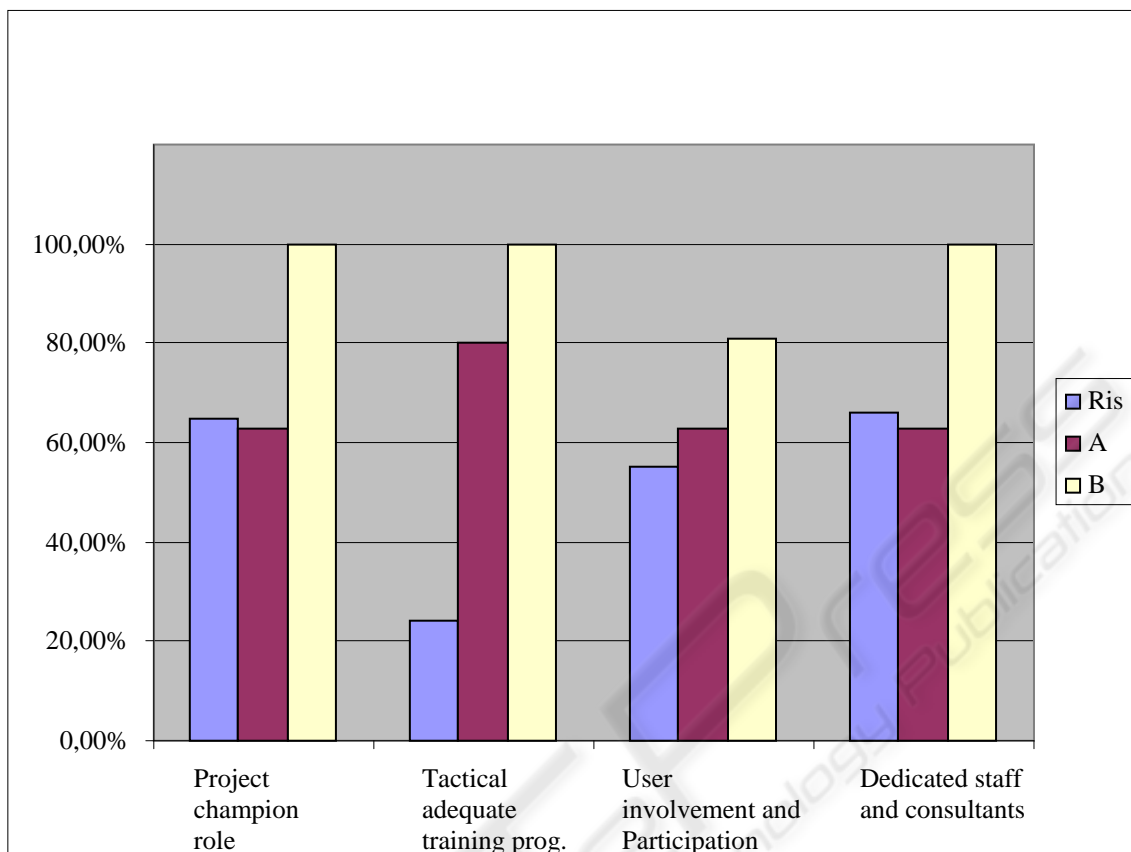
Figure 1: CSF scores in RIS BVand the reference organisations A and B.

REFERENCES

Aladwani A.M., 2001, *Change management strategies for successful ERP implementation*, Business Process Management Journal, Vol. 7 No. 3, pp. 266-275, MCB University Press, 1463-7154.

Amoako-Gyampah K., A.F. Salam, 2003, *An extension of the technology acceptance model in an ERP implementation environment,* Information & Management.

Esteves J., J. A. Pastor, 2004, *Organizational and Technological Critical Success Factors Behavior along the ERP Implementation Phases, in:* Proceedings of the Sixth International Conference on Enterprise Information Systems, Porto, Portugal, April 14-17.

Esteves J., J. Pastor, J. Casanovas, 2003, *A Goal/Question/Metric research proposal to monitor user involvement and participantion in ERP implementation Projects*, Information Resources Management Association Conference (IRMA), Philadelphia (USA).

Esteves J., Pastor J., 2000, Towards the Unification of Critical Success Factors for ERP Implementation, 10th Annual BIT conference.

Hoon Nah F.F.,J.L. Shang Lau, 2001, *Critical factors for successful implementation of enterprise systems,* Business Process Management Journal, Vol. 7 No. 3, pp. 285-296. MCB University Press, 1463-7154.

Kitchenham B..A., 1996, *Software metrics: measurement for software process improvement*, NCC Blackwell Publishers

Klaus H., M. Rosemann, G.G. Gable, 2000, *What is ERP?* Information Systems Frontiers, 2:2, 141-162.

Krumbholz M., N. Maiden, 2001, *The implementation of enterprise resource planning packages in different organisational and national cultures*, Information Systems, 26 , 185-204.

Marble R.P., 2003, *A system implementation study management commitment to project management,* Information & Management 41, 111–123.

Markus M.L., C. Tanis, 2000, *The enterprise system experience – from adoption to success",* in Zmud, R.W. (Ed.), Framing the Domains of IT Management: Projecting the Future Through the Past, Pinnaflex Educational Resources, Inc., Cincinatti, OH, pp. 173-207.

Mendoza, Pérez, Grimán, 2006, *Critical Succes Factors for Managing Systems Integration*, Information Systems Management, Volume 23, Issue 2 pages

56 - 75

Perez M., Griman A., Mendoza L., Rojas T., 2004, A Systemic Methodological Framework for IS Research. Proceedings of the Tenth Americas Conference on Information Systems, New York.

Solingen R., E. Berghout, 1999, The Goal/Question/Metric Method, A practical guide for quality improvement of software   development, McGraw-Hil.

Stelzer D., W. Mellis, 1998, *Success Factors of Organizational Change in Software Process Improvement,* Software Process: Improvement and Practice 4, 227-250.

Trienekens J.J.M., R.J. Kusters, R. van Solingen, 2001, *Product Focused Software Process Improvement: Concepts and Experiences from Industry,* Software Quality Journal 9, 269-281.

Wohlin C., A. Amschler Andrews, 2001, Assessing Project Success Using Subjective Evaluation factors, Software Quality Journal, 9, 43-70.