Complexity impact factors on the integration process of ERP and non ERP systems: a basis for an evaluation instrument

COMPLEXITY IMPACT FACTORS ON THE INTEGRATION PROCESS OF ERP AND NON ERP SYSTEMS

A Basis for an Evaluation Instrument

Guy Janssens [1], Marinus Hoeijenbos [2] and Rob Kusters [1, 3]

[1] *Open Universiteit Nederland, School of Management, P.O. Box 2960, 6401 DL, Heerlen, The Netherlands*

[2] *Nedstaal b.v., P.O. Box 210, 2950 AE, Alblasserdam, The Netherlands*

[3] *Eindhoven University of Technology, Department of Technology Management P.O. Box 513, 5600 MB, Eindhoven, The Netherlands*

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Abstract: This study shows an expert confirmed initial list of factors which influence the complexity of the integration process of ERP systems and non ERP systems. After a thorough search for complexity factors in scientific literature, a survey amongst 8 experts in a leading European long special steel products company, which was recently composed out of independent international companies, was conducted. The participants confirmed the retrieved list from literature, consisting of 5 quantitative and 21 qualitative factors. The participants added one extra qualitative factor and scored the importance of all factors. Three quantitative factors, i.e. a technology, a business and a project factor, scored highest. When dealing with integration issues, this initial list of factors can provide awareness for organizations to support activities such as planning, control and risk management.

1 INTRODUCTION

Most organizations own a portfolio of many different systems of software modules from different suppliers (Lemahieu et al., 2003, Themistocleous et al., 2004, Light et al., 2001), often based on different standards, programming languages and operating systems and unfortunately often insufficiently documented (Themistocleous et al., 2004). In many organizations integration of Enterprise Resource Planning (ERP) systems with other systems has been shown to be complex (Sammon and Adam 2005; Sharif et al., 2005). There are several reasons for this complexity: ERP systems have a monolithic character and initially were not designed to work with other information systems (Klaus et al., 2000). Also ERP systems have limited flexibility because ERP systems force organizations into adapting their business processes according to the ERP system designers view on these business processes (Gibson et al., 1999; Esteves et al., 2002; Koch, 2001). However unique business processes can provide competitive benefits, which forces the organization to use custom build information systems and integrate them with their ERP system. Besides that, there is a growing need for integration between supply chain partners for reasons of cost reduction and coping with the worldwide competition. What's more, instead of using one ERP system for every business process in an organization, there is a tendency for using the best modules of different ERP suppliers. This Best of Breed (B.o.b.) solution prevents insufficient support of the business processes or costly customization (Alshawi et al., 2004; Light et al., 2001), but causes additional effort for integration of the separate modules. From this we may infer that integrating an ERP system with other systems is an important and complex process in an ERP implementation project.

Understanding factors that influence this complexity should support integration activities. Therefore this paper discusses the results of an initial survey based study into the most important factors which influence the complexity of the implementation process when integrating non ERP systems with ERP systems. First the research goal and approach is described. Second the concept of integration in this research is explained. Third, the complexity factors that influence complexity retrieved from literature are shown. After that, the

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survey method is discussed, the results from the survey are shown and finally the results, conclusions and further research are discussed.

2 RESEARCH GOAL AND APPROACH

Every information system in an organization has its own basic assumptions and technical basis. Also every system will support different business processes and therefore have a different purpose. Therefore integration of information systems within an organization, with each having their own specific characteristics, will be a complex issue. Because the organizational information systems differ in many areas but nevertheless need to be integrated, it is reasonable to assume that many factors will influence the complexity of this integration process. In the last decades ERP systems have become important information systems which in many cases act as the core or spine of the information systems architecture in an organization (Sharif et al., 2005). In most cases this core is surrounded by non ERP systems that play a vital role within the organization. These non ERP systems often support organizations in providing extra value of services in relation to their competitors or are specific to an organization, and therefore cannot be replaced by an ERP module. Since integration of ERP systems with other systems is important, this research aims at obtaining the factors which influence the complexity of the integration process between ERP systems and non ERP systems.

This was achieved by first performing an extensive literature search for verified factors that influence the complexity of the integration process of ERP systems with non ERP systems. Although several papers mention factors of influence, no research has been found which shows a comprehensive and confirmed list of such factors, and equally important, shows which factors influence most the complexity of the integration process. Therefore a novel list of factors was constructed from research literature in relevant related areas. To be of value for further research and use in ERP projects, such a list must be confirmed by empirical research. In this research a first investigation into the relevancy and completeness of this novel list has been performed by retrieving the opinion of a small group of experts. Experts seemed a pragmatic empirical source for a first confirmation of the retrieved factors, as came clear from literature that there are many views on the subject and a respectable number of factors should to be taken into account.

The purpose of this empirical research was to retrieve answers to the next questions:

1. Is the list retrieved from literature complete?
2. If not, what factors should be added to the list?
3. What is the relative importance of the factors on this (appended) list?

3 INTEGRATION

In general, integration within the IT community is the creation of links between information systems. Because of existing different interpretations of the word integration, this section will briefly discuss the concept of integration as it is used in this research.

Integration is indicated by different expressions (Themistocleous et al., 2001b, Themistocleous and Irani, 2002): Enterprise Application Integration (EAI), System Integration (SI), Value Chain Integration (VCI), Supply Chain Integration (SCI), Extended Business Integration (EBI), E-Business Integration.

All these expressions point to integration within an organization or integration across the borders of an organization. The purposes of integration for an organization are (Bhatt, 2000): reduce cost, improve services and improve synergy effects. Reducing cost is possible by efficiency improvement by integration of processes and also by reducing the maintenance cost of information systems. The improvement of services results from a faster responsiveness to changes on the market.

Gulledge (Gulledge, 2006) states that the term integration is commonly used when discussing enterprise applications. There are several definitions of the term integration such as: ‘the interfacing of systems together so they can pass information across a complex technology landscape’ (Gulledge, 2006) or ‘the extent to which data and application through different communication networks can be shared and accessed for organizational use’ (Bhatt, 2000). Unfortunately these definitions are purely oriented towards the technical aspects of integration and leave business processes out of context.

Therefore a more comprehensive paradigm of integration is: ***The integration of data resources, the integration of application functions, and the integration of business processes*** *(Fan et al., 1999).*

Because in the authors opinion,integration during an ERP project is never just a technical matter,this paper will employ the concept of integration as proposed by Fan et al. (Fan et al.,1999)

4 COMPLEXITY FACTORS IN LITERATURE

4.1 Approach

In existing literature no acknowledged list of factors was found that influences the complexity of the integration concept as defined by Fan (Fan et al., 1999). For that reason a search in ERP literature and non ERP literature was performed into factors that influence this complexity. By this search 45 relevant papers were retrieved. Only 15 discussed the research topic according to the integration concept by Fan (Fan et al., 1999). Systematic evaluation led to the identification of 8 main ***areas of influence*** concerning the complexity of integration as shown in table 1. These areas of influence are of a too high level of abstraction to be able to be useful as variables for indicating the level of complexity of an integration process. Therefore also ***factors*** within these areas of influence have been retrieved from literature, which are more concrete and if possible can be measured objectively. These factors are also shown in table 1.

The definitions, sources of retrieval, motivation why a factor influences the complexity of integration of these main areas and the list of factors with their relative importance are available from the authors.

4.2 Results

Although literature on the subject of integration is often focused on technical solutions of integration problems and on EAI, this technology focus covers only a part of the integration problem (Sharif et al., 2004). More and more suppliers of EAI technology therefore focus on products that make integration of business processes possible (Cakular and Wijngaarden, 2002). EAI not only supports automating activities, but also the improvement and change of business processes (Bhatt, 2000). Business process redesign is an important part of integration.

The quality of the implementation project itself also influences the ease of integration (Davenport, 1998; Lam, 2005; Fui-Hoon Nah et al., 2001; Sammon and Adam, 2005).

Therefore to be able to indicate complexity factors of integration, this paper discusses them using three logical viewpoints (Klesse et al., 2005, Lam, 2005, Sharif et al., 2004, Themistocleous et al., 2001a, Themistocleous et al., 2001b): ***Technology***, ***Business*** and ***Project***.

As described before, for every influence area factors have been retrieved, see table 1. In the current stage of this research it seems more important to retrieve all factors and score them according to their importance, than to do extensive research into defining variables for every factor by which a factor can be measured.

5 EMPIRICAL VALIDATION OF THE COMPLEXITY FACTORS

5.1 Introduction

In order to determine the completeness of the list and the relative importance of the factors expert judgement was sought, as this seemed a suitable source of information for this purpose.
The experts had to meet the following profile:

- Knowledge of the management of the integration process of information systems in general ;
- Knowledge of integration of ERP solutions and complementary IT solutions on at least one but preferable more of the views ‘technology’, ‘business’ and ‘project’;
- To avoid emphasis on the specific circumstanced of a single organization, they should have different organizational (at least) and national (preferably) backgrounds .

Experts should add factors if required, rate the relative importance of the factors and react on additional factors and arguments from other experts. A large-scale survey is not suitable whereas in general the availability of experts in this area and willingness to participate is limited. Therefore this research aimed at a small group of experts with sufficient knowledge willing to participate in several rounds in a Delphi setting.

5.2 Research Environment

Inviting experts from various international organizations would be the ideal research setting. On the other hand, experts should be available and being able to understand each other’s contribution, which pleads for a selection from a single organization. As a compromise we selected experts from an organization that fairly recently was created by a merger between a number of different companies.
The survey was performed amongst experts in a leading European special steel products company. This organization employs 4,300 people at 16 production sites and several sales companies in Europe and the USA. The company is in its present form a young organization, composed of different

independent steel companies in various segments of the steel market. Before consolidation the different companies had their own ERP systems, business processes and culture. In this organization there is a major focus on the integration of the different information systems caused by the consolidation of the different units. Recently merged, still variations in organization, business processes and nationality exist. It is reasonable to assume that the outcomes of the survey are of equal value as a survey amongst experts from independent organizations.

5.3 Approach

A multi round survey approach through e-mail was in this case a practical tool because of the geographical different locations of the participants. Also, the participants spoke different languages. The survey format allowed them time to understand and formulate their answers in a non-native language. The survey used the following procedure:

1. A first individual rating of the factors and identification of supplementing factors by the participants.
2. Analyzing these additional factors and construction of the final list of factors.
3. Rating of the final list of factors by the participants by the Delphi technique in several rounds until changes in rating per round were minimal.

The survey consisted of predefined questions with predefined answers and in round one an additional open question about supplementary factors.

5.4 Participants

The group consisted of 5 IT Managers, 1 CFO, 1 IT software developer and 1 Information analyst. Also the group was composed of 3 persons from Finland, 1 person from Sweden and 4 from the Netherlands.

6 RESULTS

In the first round, all participants received a questionnaire with the view points, areas of influence and factors. Every factor contained a definition and a reason for inclusion as derived from literature. The participants were invited to ad and motivate factors they missed and rate every factor on a 5 points Likert scale (very small to very big influence) along with a motivation. The respondents added one additional factor, number 27 in table 1

In the second round, all participants again

Table 1: Factors, references and scores.

Viewpoint		
	Areas of influence	
	ID.	Factor
Technology		
	Application Portfolio	
	1.	Number of applications
	2.	Number of different application types
	Choosing the right integration technology	
	3.	Extend to which functionality of EAI technologies overlap
	4.	Quality of available integration technologies
	5.	Number of available and necessary (now and in the future) pre-built adapters
	6.	Possibility to develop custom adapters
	7.	Availability, within the organization, of a tool to select the necessary EAI technology
	Information Management	
	8.	Common layer with definitions of objects, relations between objects and business rules
	9.	Strategy to handle data redundancy, replication and inconsistence over applications
	IT sophistication	
	10.	Technical knowledge, within the organization, concerning the current IT infrastructure
	11.	Technical knowledge, within the organization, concerning the new EAI technology
	Technical Goals to be met	
	12.	Level of integration from a technical point of view
	13.	Quality of the new IT-infrastructure
	27. Availability of new EAI technologies and/or ERP solutions	
Business		
	Business Goals	
	14.	Level of integration, from a business point of view
	15.	Number of organizations that need to be integrated.
	16.	End-customer integration.
	17.	Business goals to be met
	18.	Level of external pressures that are forcing the organization to adopt EAI
	19.	Stakeholders goals differ
	Knowledge and skilfulness in changing the organization	
	20.	Specific EAI knowledge and skills within the organization.
	21.	Ability of an organization to adopt new technology.
	22.	Employee knowledge of processes
	23.	Willingness employees to share control & ownership of processes
Project		
	Differences between EAI and traditional IT projects	
	24.	Availability of proven EAI methods within the organization
	25.	Integration of all existing applications within a portfolio of applications rather than the selection of development of one new application
	26.	Number of project owners and stakeholder groups

received the questionnaire. Besides the views and factors, it contained the summarized motivations from the previous round as well as factor 27. Round 2 did not lead to a major change of opinions. For this reason it was decided to stop the survey and use the results retrieved so far, supported by the announced unwillingness of the participants to participate in a third round.

Table 2 shows the 5 top rated factors, while table 3 displays the 5 factors with the lowest scores, both in descending order. The complete list of scores of all factors after round 2 is available through the authors.

Table 2: The 5 top rated factors.

Id	Factor
15	Number of organizations that need to be integrated
1	Number of applications.
26	Number of project owners and stakeholder groups
6	Possibility to develop custom adapters.
23	Willingness of employees to share control & ownership of processes.

Table 3: The 5 lowest rated factors.

Id	Factor
7	Availability, within the organization, of a tool to select the necessary EAI technology
24	Availability of proven EAI methods within the organization
11	Technical knowledge, within the organization, concerning the new EAI technology
9	Strategy to handle data redundancy, replication and inconsistence over applications
20	Specific EAI knowledge and skills within the organization

7 CONCLUSIONS

All complexity factors identified from literature are confirmed by the participants in this survey. Although not all are rated equally important, all factors were scored at least a 'small' to 'normal' influence on complexity. However it is also reasonable to assume that the rating will somewhat be influenced by organization specific characteristics. According to the participants of the survey, clearly some factors have more influence on complexity.

The list of the retrieved factors seems rather comprehensive, given that only one factor was added by the participants that was not in the original list and that this factor was rated as having a normal influence on complexity. This fact and that all factors scored as relevant, suggest that the final list is not heavily influenced by the specific circumstances in this organization. If this would be the case, the authors would expect an explicit variation in the scores.

This survey confirms that integration should not be viewed as a pure technical matter. Three out of the five most important factors are non technical factors. Two factors have an organizational view and one factor a project view. The list in table 1 consists of 5 quantitative factors (ID's 1, 2, 5, 15 and 26) and 22 qualitative factors. This might suggest that qualitative factors play an important role in the complexity of integration. However the list of the 5 top rated factors shows 3 quantitative factors and 2 qualitative factors. The 2 most important factors are quantitative factors. Also the list shows that the 3 quantitative factors belong to the 3 different viewpoints.

The authors expect that the present list of qualitative and quantitative factors is already a useful instrument for organizations to determine and value the relevant factors which influence the complexity of their integration of ERP with non ERP systems. It can be useful as an instrument for recognition and structured discussion of the important factors which influence the complexity of integration. Usage should provide awareness of the condition of a specific factor in a particular organization in areas like planning, control and risk management.

8 DISCUSSION

In this research only the relevant influence factors have been retrieved. Relationships between factors are not discussed although at a glance factors seem related to each other. For instance the 3 top factors, probably will have a high correlation. For example the higher the number of organisations are, probably the higher the number of applications will be. This aspect should be addressed by further research because this might lead to simplifying the model i.e. reducing or condensing the number of relevant factors.

Of course it would also be very useful for an organization if they could match the factors to the complexity of the integration and match this to the integration effort. Research into finished projects can relate their integration effort to the factors retrieved in this research.

Finally, as the current list is a novel one

confirmed by only 8 experts in 3 European countries, more research should be undertaken into the comprehensiveness the areas of interest, the factors and the relative importance of these factors.

Nevertheless the present rated list of qualitative factors can serve as starting point for further research.

REFERENCES

Alshawi, S., M. Themistocleous & R. Almadani, 2004. Integrating diverse ERP systems: a case study. *Journal of Enterprise Information Management,* 17**,** 454 - 462.

Bhatt, G. D., 2000. An empirical examination of the effects of information systems integration on business process improvement. *International Journal of Operations & Production Management,* 20**,** 1331 - 1359.

Cakular & v. Wijngaarden, 2002. Succesvolle EAI. In *Informatie*, 72-76.

Davenport, T. H., 1998 Putting the enterprise into the enterprise system. *Harvard Business Review,* 76, 121-+.

Esteves, J., J. Pastor & J. Casanovas, 2002. Monitoring Business Process Redesign in *ERP Implementation Projects. Eighth Americas Conference on Information Systems.*

Fan, Y. S., W. Shi & C. Wu, 1999. Enterprise wide application integration platform for CIMS implementation. *Journal of Intelligent Manufacturing,* 10**,** 587-601.

Fui-Hoon Nah, F., J. Lee-Shang Lau & J. Kuang, 2001. Critical factors for successful implementation of enterprise systems. *Business Process Management Journal* 7**,** 285 - 296

Gibson, N., C. P. Holland & B. Light, 1999. Enterprise Resource Planning: A Business Approach to Systems Development. *Proceedings of the 32nd Hawaii International Conference on System Sciences - 1999***,** 9.

Gulledge, T., 2006. What is integration? *Industrial Management & Data Systems,* 106**,** 5 - 20.

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

Klesse, M., F. Wortmann & J. Schelp, 2005. Success factors for application integration. *Wirtschaftsinformatik,* 47**,** 259-267.

Koch, C., 2001. BPR and ERP: Realising a vision of process with IT. *Business Process Management Journal,* 7**,** 258.

Lam, W., 2005. Investigating success factors in enterprise application integration: a case-driven analysis. *European Journal of Information Systems,* 14**,** 175-187.

Lemahieu, W., M. Snoeck & C. Michiels, 2003. An enterprise layer-based approach to application service integration. *Business Process Management Journal,* 9**,** 760 - 775.

Light, B., C. P. Holland & K. Wills, 2001. ERP and best of breed: a comparative analysis. *Business Process Management Journal,* 7**,** 216 - 224.

Sammon, D. & F. Adam, 2005 Towards a model of organisational prerequisites for enterprise-wide systems integration: Examining ERP and data warehousing. *Journal of Enterprise Information Management,* 18**,** 458 - 470.

Sharif, A. M., T. Elliman, P. E. D. Love & A. Badii, 2004. Integrating the IS with the enterprise: key EAI research challenges. *Journal of Enterprise Information Management,* 17

Sharif, A. M., Z. Irani & P. E. D. Love, 2005. Integrating ERP using EAI: a model for post hoc evaluation. *European Journal of Information Systems,* 14**,** 162-174.

Themistocleous, M. & Z. Irani, 2002. Novel taxonomy for application integration. *Benchmarking: An International Journal,* 9**,** 154 - 165.

Themistocleous, M., Z. Irani & P. E. D. Love, 2004. Evaluating the integration of supply chain information systems: A case study. *European Journal of Operational Research,* 159**,** 393-405.

Themistocleous, M., Z. Irani & R. M. O´Keefe, 2001a. Benchmarking the benefits and barriers of application integration. *Benchmarking: An International Journal,* 8**,** 317 - 331.

Themistocleous, M., Z. Irani & R. M. O´Keefe, 2001b. ERP and application integration: Exploratory survey. *Business Process Management Journal,* Vol. 7**,** 195-204.