Journal of Industrial and Systems Engineering
Vol. 2, No. 1, pp 51-74
Spring 2008

JISE

An EFQM Based Model to Assess an Enterprise Readiness for ERP Implementation

Rasoul Shafaei*, Nooraddin Dabiri

Department of Industrial Engineering, K.N.Toosi University of Technology, Tehran, Iran

ABSTRACT

In today's competitive market, Enterprise Resource Planning (ERP) system is widely being used by industries. However, the results of the research efforts carried out in this field reveal that the rate of successful implementations for ERP projects is low and in most cases the planned goals are not achieved. Therefore it is necessary to assess maturity of an enterprise in terms of factors affecting a successful implementation of an ERP system. This paper proposes an EFQM based model to assess the readiness of an enterprise for effective and successful ERP implementation. First, the main factors affecting the implementation of an ERP system, called Critical Success Factors (CSF) are identified. Then relations between the factors defined in EFQM model and ERP CSFs are investigated by means of questionnaires by experts working in this field. The results identify those EFQM factors which are related to ERP CSFs. In addition, those ERP specific factors which are not considered in the EFQM model are identified. Consequently a model based on EFQM including ERP specific CSFs is developed. The proposed model is applied to assess the readiness of a company intending to implement an ERP system. Finally the results of the assessment are discussed and concluding remarks are presented.

***Keywords*:** Enterprise resource planning, Readiness assessment, Critical success factors, EFQM

1. INTRODUCTION

Enterprise Resource Planning software is an integrated application module based package which covers most of the business process and functions of an enterprise. The current ERP software is flexible and can be dynamically configured and customized to meet the requirements of enterprises. ERP systems have now been expanded to support supply chain process, sales functions and customer service. Examples of enterprise systems are Enterprise Resource Planning System (ERP), Product Data Management and Product Lifecycle Management System (PDM/PLM), Customer Relation Management (CRM) and other various advanced collaboration tools offering shared workspace for, often dispersed, parties involved in collaborative works. In addition many other integrated packages can be found under different names (Wongnum et al., 2004).

One of the major benefits of ERP systems is that all enterprise data are collected during the transaction, stored centrally, and updated in a real time. This ensures realistic plans upon which an enterprise can be managed effectively and data are updated in real time (Bancroft et al., 1998). Ptak and Schragenheim (2004), state that one of the main benefits of a successful ERP implementation is

* Corresponding Author:

to make useful information available. This helps managers to make effective decisions. Shang and Seddon (2000) also classify ERP benefits into five groups as follows:

- *Operational*, relating to cost reduction, cycle time reduction, productivity improvement, quality improvement, and customer services improvement.

- *Managerial*, relating to better resource management, improved decision making and planning, and performance improvement.

- *Strategic*, concerning supporting business growth, supporting business alliance, building business innovations, building cost leadership, generating product differentiation, and building external linkages.

- *IT infrastructure*, helping to build business flexibility, IT cost reduction, and increased IT infrastructure capability.

- *Organizational*, relating to support organizational changes, facilitating business learning, empowering, and building common visions.

ERP systems can also help organizations to manage their key resources, among which one can mention money, staff, products, customers and suppliers, more effectively (King and Burgess, 2006). Therefore it can be concluded that the effectiveness of ERP systems in enterprises can not be ignored. The recent rapidly growing implementation of this system in various enterprises supports such claim.

While enterprise systems hold tremendous promise for enhancing organization performance, much of the potentials are never realized (Kown, 1987; Nash, 2000). This means implementation of such system in an enterprise is a very difficult process. Many ERP projects partially or even totally fail to achieve the goals defined before implementation (KPMG, 2002). The results of the research efforts reveal that the failure rate of ERP implementation projects is significantly high (Ng et al., 1999; Buckhout et al., 1999; Langenwalter, 2000; Brown, 2001; Gefen, 2002; Abdinnour-Helm et al., 2003; Umble et al., 2003; Liang and Xue, 2004; Ptak and Schragenheim., 2004; Xue et al., 2005; Ehie and Madsen, 2005). Ptak and Schragenheim (2004) define failure as an implementation that does not achieve the goals defined in the project approval phase. The result of his investigation reveals that failure rates in ERP implementations are in the range of 60–90%. In 2002, a survey conducted by KMPG (2002) on implementing program management of 134 organizations in US, Africa, Australia and Europe reveals that about 60% of the companies studied have experienced failed projects within previous years at an average cost of 12 million Euros each. Some of the projects studied were ERP projects. Vendor switching and/or system abandonment typically provide signals of prior implementation failure or significant prior implementation difficulties (Nikolaou, 2004).

One of the reasons for the failure is that implementing an enterprise system in a company is a complex process. It is not only because of the newness of many different aspects that need to be considered at the same time, but also because of the impacts of the new system on the organization. Beside that there are some other reasons for the complexity of ERP systems which are summarized below (Wognum et al, 2004).

- Differences between the implementation process and organization daily routine works.

- ERP implementation process is normally considered as a technical endeavor whereas this is an organizational change and evolution process (Davenport, 2000).

- Implementation process is normally discontinuous and hence the experiences are lost.

- Lack of alignment between an enterprise system and existing technology.

- Unsuitable project team for implementing ERP system which normally occurs because managers normally are not willing to release their best employees for the projects (Welti, 1999).

- Employees and middle management have usually very limited involvement in a system definition and implementation and hence face a lack of ownership (Welti, 1999).

Problems associated with an ERP implementation are often classified into technical and organizational aspects (Lea et al, 2005). Technical aspects include the technology readiness of an organization, the complexity of ERP software, data loss due to the incompatibility of data architectures between the old legacy systems and the new ERP software (Slater, 1998), and inadequacies of newly redesigned business processes (Oliver, 1999; Baatz, 1996). Common organizational factors may include employees' resistance to change, inadequate training, underestimated cost and time of implementation, unwillingness to adopt new business processes, and strategic view of technology adoption (Slater, 1998; Joshi and Lauer, 1999; Mabert et al., 2001). Ptak and Schragenheim (2004) also argue that one of the reasons for ERP implementation failure is lack of organizational readiness in terms of business process maturity, cultural, technological and organizational aspects. In addition, in case the implementation process takes longer than the plan, the implementation team loses its motivation (Ptak and Schragenheim 2004).

With the above reviewed facts, in order to implement an effective and successful ERP system it is highly important to evaluate the enterprise readiness before starting the project. A review of the research works conducted on ERP implementation indicates that little studies on assessment of enterprise readiness for ERP system implementation have been carried out. Some of the studies in this field are reviewed below.

Ptak and Schragenheim (2004) suggested an Enterprise Resource Management (ERM) assessment checklist with twenty five questions. The readiness of an organization on implementing an ERP system is scored in terms of a number of criteria each one varying in a range between zero and four. Despite the fact that this research can be considered as one of the important ones on assessing the readiness of an organization for successful implementation of ERP, this approach has some shortcomings. For instance, the approach has considered customer orientation and effective implementation of 6 Sigma as main factors affecting successful implementation of an ERP system whereas factors such as IT infrastructure, the degree of business processes maturity and their integration have been ignored.

Banijamali et al (2005) also investigated the main factors affecting the implementation of ERP in an enterprise and suggested a ranking mechanism whereby the readiness of an enterprise can be assessed in terms of a number of different aspects. One of the works mostly related to this research belongs to Wongnum et al. (2004) who developed a framework to assess the readiness of an enterprise for implementing an ERP system. The project called BEST (Better Enterprise System implemeTation). It is a Process-based Model for Organizations (PMO). They considered three processes co-existing and interacting in an enterprise system implementation project and called them dimensions. The level of maturity of each dimension indicates the degree of maturity or

alignment between different dimensions in the reference framework. The dimensions are the design and tuning of a new enterprise system which includes project management, implementation process and permanent business processes. The elements of the model are called aspects which include strategy and goals, management, structure, process, knowledge and skills and social dynamics which refers to the behavior of people. A prototype tool has been developed with all questions, answers and scores that have been defined. In this approach a set of questions is designed and asked for the degree of maturity of a particular situation or the degree of alignment between dimensions. The application of the proposed approach was tested by a number of experts who gave a promising feedback. Despite the fact that the proposed approach was claimed to be a good framework for assessing the readiness of an enterprises, the authors opt for further investigations to provide more comprehensive aspects and dimensions whereby the readiness of an enterprise to implement ERP systems can be assessed effectively.

2. RESEARCH METHODOLOGY

The research methodology is schematically shown in Figure 1. In this research first, Critical Success Factors (CSF) which have significant effects on successful implementation of ERP are identified by an extensive literature review. The listed factors cover various dimensions of enterprises which have been found to influence the implementation of an ERP system. In order to find an appropriate framework for evaluating the readiness of an enterprise for ERP implementation, it is necessary to assess the maturity of an enterprise in terms of the factors affecting successful implementation of an ERP system. For this purpose the authors tested the effectiveness of EFQM approach for such assessment. Therefore the relations between CSFs and EFQM criteria were investigated in two stages. In the first stage, the relations were studied using Delphi method by interviews with a number of experts including academic experts and practitioners. In the next stage, the relations between CSFs and EFQM criteria were deeply investigated using questionnaires and interviews with 30 experts working in industry. The selected industries had either decided to implement ERP system and were evaluating the available systems and implementers or were implementing a selected ERP system. The results of the investigation shed light on the relations between CSFs and EFQM criteria. Having confirmed such a relation, an EFQM model, as a well known approach for evaluating an enterprise business excellence, is applied for the assessment. Finally the model is applied to assess the readiness of a company which is deciding to purchase an ERP system.

3. ERP CRITICAL SUCCESS FACTORS

Several research attempts have been carried out to find factors that have significant impacts on successful implementation of an ERP project. These factors are called ERP Critical Success Factors (CSFs). Umble et al. (2003) classify ERP implementation into nine categories as clear understanding of strategic goals, commitment by top management, excellent project management, organizational change management, a great implementation team, data accuracy, extensive education and training, focused performance measures and multi-site issues. Al-Mashari et al. (2003) also identify twelve critical factors of ERP projects and their taxonomy on three phases of ERP project as follows:

- Setting up

    1- Management and Leadership
    2- Visioning and Planning

- Implementation

  3- ERP Package Selection
  4- Communication
  5- Process Management
  6- Training and Education
  7- Project Management
  8- Legacy Systems Management
  9- Systems Integration
  10- Systems Testing
  11- Cultural and Structural Changes

- Evaluation

  12- Performance Evaluation and Management

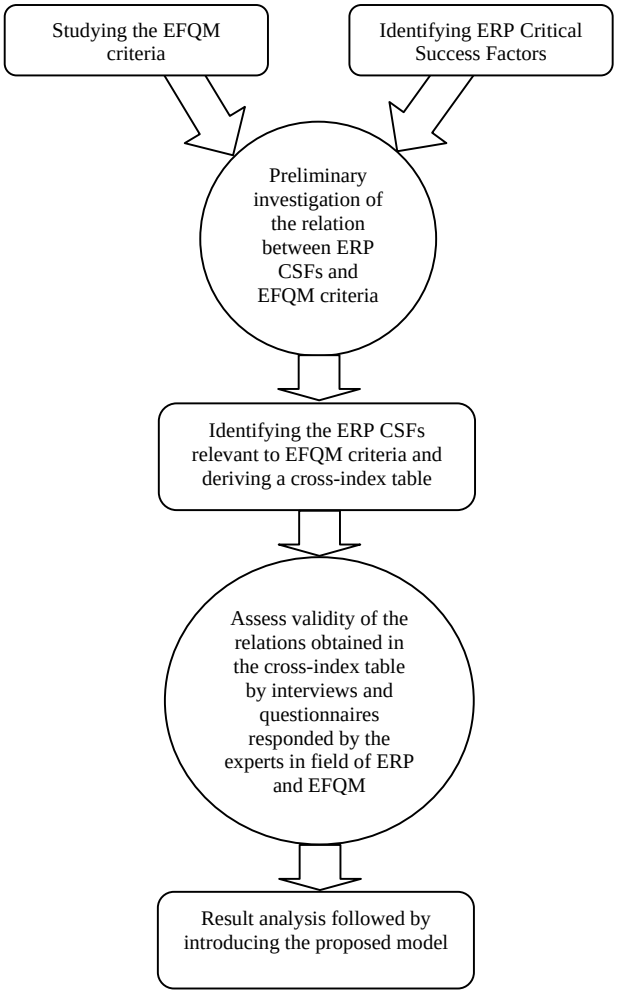

Figure 1: Research Methodology

For more details on the research works carried out on investigating the factors affecting the implementation of ERP system, the readers are referred to the works carried out by Holland and Light, 1999; Summer, 1999; Hong and Kim, 2002; Umble et al., 2003; Al-Mashari et al., 2003; Ehie and Madsen, 2005; Wang et al., 2005; Sun et al 2005; Wang and Chen, 2006; Yusuf et al, 2004; Lam, 2005; Akkermans and Helen 2002; Kositanurit, et al 2006.

Recently some researchers have also focused on comparing the implementation cases in several companies and studied their differences. This way they suggest some more factors in ERP implementation project (Motwani et al., 2002; Sarker and Lee, 2003; Sheu et al., 2004; Zhang et al., 2005; Yusuf et al., 2004; Xue et al., 2005; Tchokogue et al., 2005; Nandhakumar et al., 2005; Rikhardsson and Kræmmergaard, 2006).

Table 1. List of ERP main Critical Success Factors

Critical Success Factors (CSFs)	Corresponding references
1. top management Support	Bingi et al (1999), Umbel et al(2003), Mabert et al (2003)
2. clear goals and objectives	Al-Mashari (2003), Umbel et al(2003), Ptak et al (2004)
3. suitable ERP package	Rao (2000), Davenport (1998), Al-Mashari (2003)
4. training and education	Hutchins (1998), Umbel et al (2003), Ptak et al (2004)
5. system integration capability	Bingi et al (1999), Al-Mashari (2003)
6. interdepartmental communication	Mabert et al (2003), Ptak et al (2004)
7. project management	Al-Mashari (2003), Zhang et al (2005)
8. system testing and error remedying	Al-Mashari (2003), Banijamali et al (2005)
9. process re-engineering	Banijamali et al (2005), Motwani et al (2005)
10. legacy systems	Holland et al (1999), Al-Mashari (2003)
11. comprehend the change necessity	Yusuf et al (2004), Ptak et al (2004), Botta et al (2005b)
12. performance measurers determination	Umbel et al(2003), Mabert et al (2003)
13. organizational commitment to change	Umbel et al(2003), Mabert et al (2003)
14. bench-marking	Al-Mashari (2003), Mabert et al (2003)
15. proper using of consultant's ideas	Umbel et al(2003), Ptak et al (2004), Zhang et al (2005)
16. consultant knowledge and experiences	Umbel et al(2003), Zhang et al (2005), Chand et al (2005)
17. change management capabilities	Al-Mashari (2003), Umbel et al(2003)
18. encourage team working and users to act effectively	Ptak et al (2004), Banijamali et al (2005), Motwani et al (2005)
19. multi-site issues	Umbel et al(2003), Olson (2004)
20. organizational culture on team working	Rajagopal (2002), Al-Mashari (2003), Jones et al (2005)
21. confidence among project players	Gyampah et al (2004), Botta et al (2005a)
22. presence the project champion	Banijamali et al (2005), Motwani et al (2005)
23. appropriate implementation approach	Olhager et al (2003),), Mabert et al (2003), Botta et al (2005c)
24. degree of customization	Umbel et al(2003), Mabert et al (2003)
25. IT infrastructure	Rao (2000), Rajagopal (2002), Zhang et al (2005)
26. empowering the implementation team	Rajagopal (2002), Ptak et al (2004), Botta et al (2005a)
27. software consistency with community rules	Xue et al (2005), Banijamali et al (2005)
28. planning and scheduling the project	Mabert et al (2003), Umbel et al(2003), Ptak et al (2004)
29. motivating the personnel to collaborate	Motwani et al (2002), Banijamali et al (2005)
30. data accuracy and integrity	Al-Mashari (2003), Umbel et al(2003), Ptak et al (2004)
31. appropriate allocation of resources and responsibilities	Motwani et al (2002), Umbel et al(2003), Ptak et al (2004)
32. communication with stockholders	Kumar et al (2002), Mandal et al (2002) Mabert et al (2003)
33. too much analysis the mistakes	Ptak et al (2004), Banijamali et al (2005)
34. great implementation team	Umbel et al(2003), Ptak et al (2004)
35. system upgradeability	Mabert et al (2003), Botta et al (2005a), Zhang et al (2005)
36. vendor experiences and credibility	Pui Ng et al (2002), Zhang et al (2005)
37. vendor support	Ptak et al (2004), Banijamali et al (2005)
38. having right expectations from software	Umbel et al(2003), Ptak et al (2004)
39. documentation and improvement	Thomas et al (2001), Ptak et al (2004)
40. celebrating	Umbel et al(2003), Ptak et al (2004)

A review of successful ERP implementations shows that top management support and commitment is the most critical factor in organizations embarking on ERP implementation, as they ensure a smooth change management and system rollout (Bingi et al., 1999). Another important factor is training and education that is probably the most widely recognized critical success factor, because user understanding and buy-in is essential. There are many other critical factors that affect ERP

implementation. To summarize the outcome of the above mentioned research works, Table 1 presents the main CSFs along with the corresponding references. For a more detailed treatment of this subject the readers are referred to Dabiri (2007).

4. EFQM EXCELLENCE MODEL

The EFQM Excellence Model was introduced in early 1992 as a framework to assess the organization excellence. It is also used for the European Quality Award. This approach is now one of the most widely used frameworks in Europe and in some other countries and it has become the basis for the majority of national and regional quality awards (EFQM web page, 2007). The EFQM Excellence Model is a non-prescriptive framework based on 9 criteria which includes 5 criteria as *'Enablers'* and four criteria as *'Results'*. The *'Enablers'* criteria cover what an organization does while the *'Results'* criteria cover what an organization achieves. *'Results'* are caused by *'Enablers'* and *'Enablers'* are improved using feedback from *'Results'* (EFQM web page, 2007).

In order to evaluate the level of an organization excellence, a quantitative approach is used to score the excellence level in a range between 0 and 1000. The list and maximum score for each of enabler and result criteria are as follows: (The scores are presented in the parenthesis).

- Enablers criteria (500)

  1- Leadership (100)

  2- Policy and Strategy (80)

  3- People (90)

  4- Partnership and Resources (90)

  5- Processes (140)

- Results criteria (500)

  6- People Results (90)

  7- Customer Results (200)

  8- Society Results (60)

  9- Key Performance Results (150)

Therefore nine criteria are used to assess an organization's progress towards excellence. A structured and clear procedure has been developed to score each individual criterion. In order to determine the scores, each criterion is supported by a number of elements which pose a number of questions, called guidance points, that should be considered in the course of an assessment. For each element a structured guideline has been developed so that an auditor can easily assess the company and score the element (EFQM web page, 2007).

The structure of EFQM enabler criteria is presented in Figure 2. The vertical boxes show the enabler criteria, slant boxes represent the element for each criterion and the relevant guidance points are shown on the bottom. The results criteria also have the same structure.

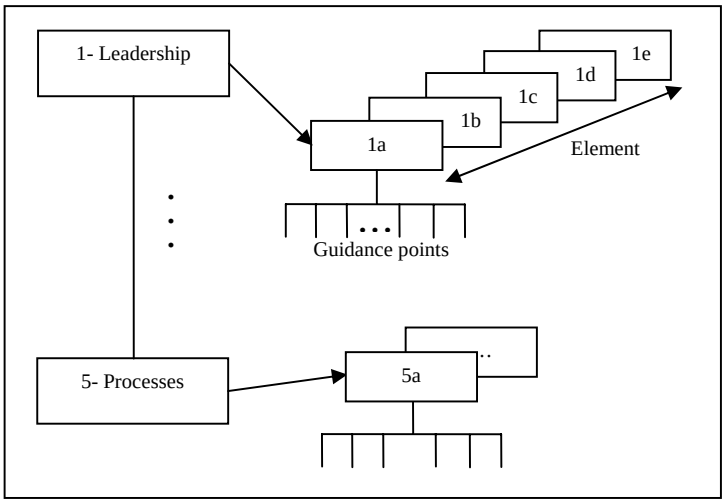

Figure 2. The structure of EFQM enabler criteria

In this study, the investigation on the relation between CSFs and EFQM criteria is limited to enabler's criteria. One of the reasons is a similarity between the elements with the corresponding guidance points of the enablers criteria with those of the results'.

5. INVESTIGATION OF THE RELATION BETWEEN ERP CSFs AND EFQM CRITERIA

An overview of CSFs and EFQM criteria suggests possible relations between them. In this section such a relation is investigated and the results are presented. In order to make a fairly accurate comparison, the CSFs are compared with the elements and subsequent guidance points of EFQM model. This enabled the investigators to assess the relations between CSFs and EFQM criteria more effectively. To start with, a preliminary table consisting of a list of elements with corresponding guideline points and CSFs related to each guidance point was provided. This table was obtained through personal contacts with the experts in the field.

Having established a preliminary relation between CSFs and EFQM criteria, the next step was to find out if such relations were valid. The validation of the relations was examined in two stages. First the preliminary relations obtained were reviewed by two experts from academia (with good knowledge on EFQM) and four experts from industry who were certified as EFQM auditor and had a good knowledge in the area of ERP. An extensive interview was conducted with these six experts where the relations between CSFs and EFQM criteria were reviewed and subsequent corrections on the relations were made. Table 2 shows the subsequent relations. In this table the column on the left hand side presents EFQM criteria (as enablers), the second column presents elements and the first row shows the guidance point (as sub element) associated with each element. The numbers in each cell indicates the CSF number (as showed in Table 1) relevant to each guidance point. For instance, numbers 13, 18 and 29 in the hashed cell show that guidance point number 8 of element 1.a from leadership criteria are related to CSF factor number 13, 18 and 29. Element 1.a is defined as follows:

Table 2. Preliminary relations between EFQM enabler criteria and ERP CSFs

Criteria	Element	EFQM guidance points for each element								
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Leadership	**1a**	2			1	26-29		2	13-18-29	
	1b	3-9	9-10-25		2-9	1-9-13-17	9-10-12	9-20-29		
	1c	32	16-36-37	19-32	40	1-4-11-17				
	1d	2-20	6-20	4-6-29	4-6-29-34	18-20-40	13-20-29			
	1e	11	11	17	1-28-31	1-11-17		6-32	4-7-26	12
Policy & Strategy	**2a**	2-11-28	2-12-29-32	11-12-23						
	2b	12	4	11	3-14	3-16-36		9		10-12
	2c	2-12	6-32	11-13	11-13	15-16-36-37		32	31	
	2d	12	6-13-20-29-32		12-39					
People	**3a**		13-20-29				11-39	20		
	3b	21-26-31	4-6-7	4-6-20-29-34	20-21	7-34	20-34	6-29	2-20-22	4-12-29
	3c	6-18-20-22-29	18-29-40	21-26-34-39	34	20-26-29				
	3d	6-9	2-6-9	6-9-39	39					
	3e	2-6-21	6-18-22-29				21-39			
Partnership& Resources	**4a**		15-16-36-37		32		14-15-19	32		
	4b	3-15-31	3-9	3-9-10-12			3-9	3-9		
	4c	These aren't consist with ERP CSFs.								
	4d									
	4e	2-3-11-28	3-9-12	3-9-23	25-32	1-13-25	30		1	22-34
Processes	**5a**	3-9-24-28		3-9-24		2-10-12				
	5b	1-2-11	2-12	22-29-32	9-11-14-23	13-17-23	8	3-21-32	4	1-13
	5c	These aren't consist with ERP CSFs.								
	5d									
	5e		19-32-39	32			32			

"Leaders develop vision, mission, values and culture of the organization and consider them selves as symbols of excellence".

CSF number 13, 18 and 29 are also defined as follows:
Guidance point number 8 corresponding to element 1.a is defined as follows:

"Encourage to organizational collaboration".

- *CSF No. 13: organizational commitment to change*
- *CSF No. 18: encourage team working and users to act effectively*
- *CSF No. 29: motivating the personnel to collaborate*

6. ASSESSEMENT OF THE VALIDITY OF THE RELATION BETWEEN CSFs AND EFQM ENABLER CRITERIA

In order to evaluate the validity of the relations between CSFs and EFQM criteria as presented in Table 2, these relations were investigated in more detail using a questionnaire responded by the practitioners working in industry where they either decided to implement an ERP system or were implementing a selected ERP system. To ensure that the questioners are responded effectively, interviews with the practitioners were made when needed. The annual turnover of the companies for

Table 3. Educational and experimental backgrounds of respondents

qualifications	*Levels*	*number*	*percent*
Education	BS	13	46
	MSc	12	43
	PhD	3	11
Field of education	industrial eng.	15	54
	IT & computer	10	35
	Other	3	11
Experiences (years)	<2	1	4
	2-4	8	28
	4-6	7	25
	6-8	7	25
	>8	5	18
ERP knowledge	very good	5	18
	Good	5	18
	Medium	9	32
	Low	9	32
Other application knowledge	very good	9	32
	Good	8	28
	Medium	10	36
	Low	1	4

whom the interviewers were working varies in a range up to 100 million Euros. In this research 45 experts were asked to fill in the questionnaire and among them 30 persons responded. Among 30

responders, two of did not answered all of questions and hence were not considered in the analysis. Table 3 shows the educational and experimental backgrounds of the 28 respondents.

Table 3 shows that over 50 percent of the respondents had Msc or PhD degree. In addition, over 90 percent of the interviewers had good or relevant experience. Over 70 percent of the respondents had a good knowledge on ERP. These results give a good confidence on the effectiveness of the data colleted from the respondents.

The questionnaire used in this research contains a list of EFQM criteria plus elements with the corresponding guidance points and a list of CSFs related to each guidance point. In addition, the questionnaire has two appendixes giving a guideline on how to respond to the questions and presents detailed information on EFQM model. For more detail the readers are referred to Dabiri (2007).

In the questionnaire, for each guidance point (e.g. guidance point number 8 from element 1.a) the relevant CSFs were listed and the relation between each guidance point and each of the relevant CSF were classified into five different categories: highly related, very related, related, vaguely related and not related. The scores of 7, 5, 3, 1 and zero respectively were assigned to these categories. The questionnaire consists of 5 criteria, 24 elements and 166 guidance points all related to EFQM enablers.

Once the data were collected from the respondents, the degree of the relation between each guidance point and CSF was measured as follows:

$$DR = \frac{(100 * S)}{T} \quad (1)$$

Table 4. Outcome of the investigation on relations between CSFs and EFQM criteria

Row	Criteria	No. of Guidance point	No. of questioned relations	No. of rejected relations	Percent of rejected relations in each criterion	No. of accepted relations	Percent of accepted relations in each criterion
1	Leadership	36	81	5	6.2%	76	93.8%
2	Strategy & Policy	26	47	15	31.9%	32	68.1%
3	People	31	72	19	26.4%	53	73.6%
4	Partnership & Resources	40	47	13	27.7%	34	72.3%
5	Processes	33	37	4	10.8%	33	89.2%
Total		166	284	56	19.7%	228	80.3%

Where, *DR* is the degree of the relation between each guidance point and CSF. It varies in a range between 0 up to 100. *S* and *T* stand for the achieved and maximum achievable scores respectively and are calculated as follows:

S= [times of category selection by respondents] * [score for each category (i.e. 7, 5, 3, 1 or zero)]
T= [the total number of respondents] * [maximum achievable score on each category (i.e. 7)]

Equation (1) has been used to calculate the relation between each CSF and Guidance point of each element. The *DR* values lower than 50 percent have been interpreted as poor relations and were deleted from the list. In addition, in order to double check the possible relation between CSFs with the guidance points which were ignored in phase one, at this stage the respondents were asked to review the relations of the ignored CSF and guidance points and in case more than 50 percent of the respondents suggest any new relation, then they were added to the table.

Having reviewed the relation between CSFs and guidance points by collecting data from the respondents, a new table of relations was obtained. Table 4 shows the result of this investigation.

In general, the results indicate that there is a significant relation between CSFs and each guidance point of EFQM. The results also show the number and percentage of the rejected and accepted relations of questioned relations to each criterion. This result reveals that leadership gained the highest accepted relation to CSFs (93.8%) while Strategy and Policy has the least accepted relations (68.1%). Overall, 80.3 percent of questioned relations have been accepted.

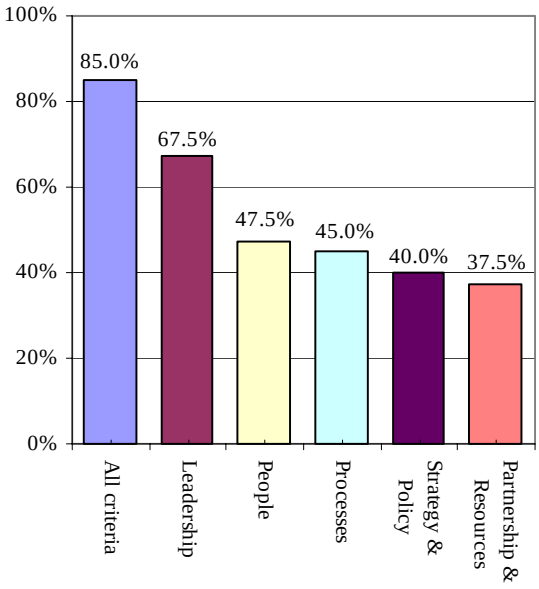

Figure 3: Percentage of CSFs related to each criterion

The correlation between the number of guidance points and the number of the questioned relations has been calculated. The results show that the correlation factor is about 0.1 which indicates a poor correlation. This means that the number of the guidance points for each criterion does not affect the

number of the questioned relations. This supports the effectiveness of the results of the investigation. Figure 3 illustrates the relation between CSFs and each criterion.

In this figure the percent of CSFs and their relations to each criterion are presented. In order to summarize the results, for each criterion, the relevant CSFs are classified into two categories. The first category includes the CSFs for which more than 50 percent of the respondents voted them as poor or very poor relation. These factors were considered as rejected factors. The second category includes the factors for which more than 50 percentage of the respondents voted them as strongly related, highly related or related factor. Figure 4 shows the percentage of the rejected and accepted factors. They are 19.7 and 80.3 percent respectively. The rejected and accepted factors are discussed in more detail below.

- **Rejected relations**

As shown in Figure 4, the percentage of the rejected factors is 19.7 percent which is relatively low. Figure 5 shows the percentage of the rejected factors in relation to each criterion. The results show that among the five criteria, human resource has the highest rate of rejected factors while the process has the lowest rate of rejected factors.

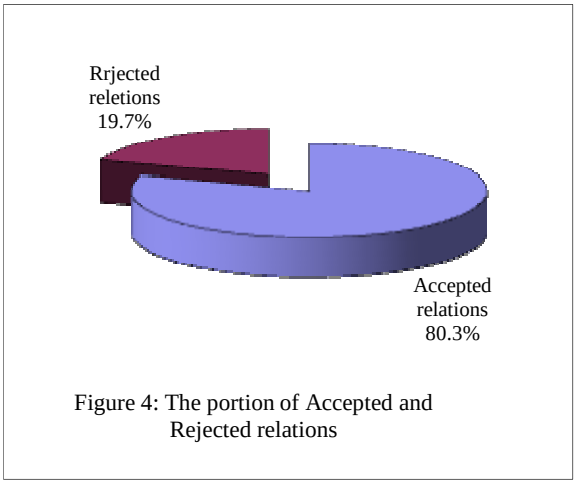

Figure 4: The portion of Accepted and Rejected relations

The results presented in Table 4 and Figure 5 indicate that leadership has the highest number of the related CSFs with the least percentage of the rejected factors. Therefore, in ERP projects it is highly important to consider the leadership as a key factor affecting the project implementation. Human resource has the second rank in terms of the number of the related CSFs but with the maximum rate of rejected factors.

In order to investigate the correlation between the number of related factors and the number of rejected factors, such correlation was calculated. The result (R=0.29) shows that the studied correlation is very weak. This result indicates that the number of related factors has no significant impact on the number of rejected factors and hence this supports the robustness of the results obtained.

The results obtained from Table 4 and Figure 6 show that among the five criteria, leadership has the highest number of related CSFs with the highest rate of accepted factors. In addition, process gained

the fourth and fifth rank in terms of the number of related factor and the rate of accepted factors respectively.

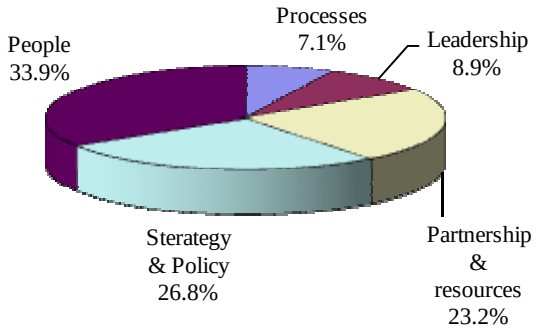

Figure 5: Contribution of each criterion from the rejected relations

In order to study the correlation between the number of related factors and the rate of accepted factors, this correlation for process, as a sample, was calculated. The result shows a weak correlation, (R=0.29). This reveals that the two parameters mentioned above have reverse and weak correlation. From this result it can be concluded that the number of related factors does not affect the rate of accepted factors.

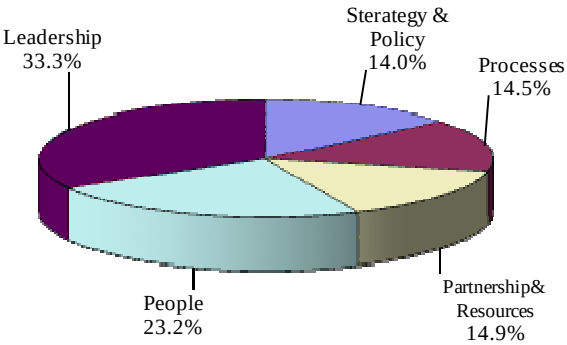

Figure 6: The share of each criterion from Accepted relations

Generally speaking, the result of the investigation presented in this paper shows that EFQM criteria mostly have significant relation with the 40 identified CSFs. This suggests that EFQM model would be used as a good framework to study the readiness of an enterprise for successful implementation of an ERP system.

7. CLASIFICATION OF THE RELATIONS BETWEEN ERP CSFs AND EFQM CRITERIA

This paper has identified the main CSFs and investigated their relation with EFQM criteria. Such relations can be divided into three categories as follows:

a) Category one: This category includes those CSFs which are related to EFQM criteria.

b) Category two: This includes those CSFs which are not related to EFQM criteria.

c) Category three: This includes those EFQM criteria with corresponding element and guidance points which are not related to CSFs.

Figure 7 shows the schematic relation among the categories. The results of the investigation indicate that among 40 CSFs, 34 factors, i.e. 85%, have relation with EFQM criteria. It shall be noted that each CSF may have relation with a number of EFQM guidance points. The number of such relation varies from one CSF to the other.

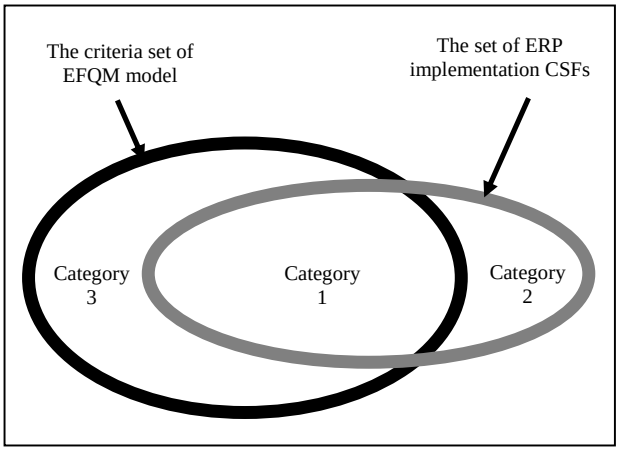

Figure 7. Relation between ERP CSF Factors and EFOM

Regarding the second category, among 40 CSFs, 34 factors have relation with EFQM criteria and 6 other factors had no significant relation. These factors are as follows:

- *system integration capability*
- *software consistency with community rules*
- *too much analysis*
- *system upgradeability*
- *vendor support*
- *having right expectations from software*

These factors are highly related to ERP and IT projects and hence were not heavily considered in EFQM model. The EFQM factors considered in category three show that 37% of the guidance points are not related to CSFs. Therefore, if an EFQM based model is used for assessing the readiness of an enterprise for ERP implementation, these guidance points can be ignored. In general, the results of the investigation presented in this section confirm a significant relation between CSFs and EFQM enabler's criteria. These results suggest that a framework similar to

EFQM can be used as a good basis for evaluating the readiness of a company to implement an ERP system. However, for effective evaluation, it is also necessary to add those ERP specific factors, not considered in EFQM, to the model.

8. FRAMWORK OF THE PROPOSED MODEL

The proposed model is based on EFQM. This includes five criteria as EFQM enablers, those named as category 1 in figure 7 as well as an ERP-specific criterion. Table 5 shows a list of the criteria, their weights obtained from the questionnaires, number of elements and guidance points for each criterion, and ratio of the guidance points omitted from the EFQM model (those which are not

Table 5. Revised enablers and their characteristics

No.	Criteria	Weigh t	No. of elements	No. of guidance points	% of guidance points that is not related to CSFs
1	Leadership	28.35	5	36	6.2%
2	Strategy & Policy	18.05	4	26	31.9%
3	People	16.75	5	32	26.4%
4	Partnership & Resources	7.45	4	40	27.7%
5	Processes	13.75	3	34	10.8%
6	ERP-specific	15.65	6	26	-
	Total	100	27	194	-

Table 6. Guidance points to measure the ERP-Specific criteria

ERP- Specific element	Guidance Points
6a- System integration capability	*1. vendor experiences and credibility* *2. consultant knowledge and experiences* *3. being a system for integrated documentation of processes* *4. using middleware* *5. being communication infrastructure*
6b- *software consistency with community rules*	*1. benchmarking from countries with similar rules* *2. implemented package in internal companies* *3. support of internal consultants*
6c- *too much analysis the mistakes*	*1. high sensitivity of management* *2. the risk of failure* *3. number of simultaneously implemented modules*
6d- *system upgradeability*	*1. ERP system selection* *2. benchmarking from best practices* *3. implementing the service oriented architecture*
6e- *vendor support*	*1. vendor experiences and credibility* *2. strong negotiation to contract* *3. making wide communication*
6f- *having right expectations from software*	*1. consultant credibility and reputation* *2. personnel knowledge and experiences* *3. review the implementation process by management* *4. great internal implementation team*

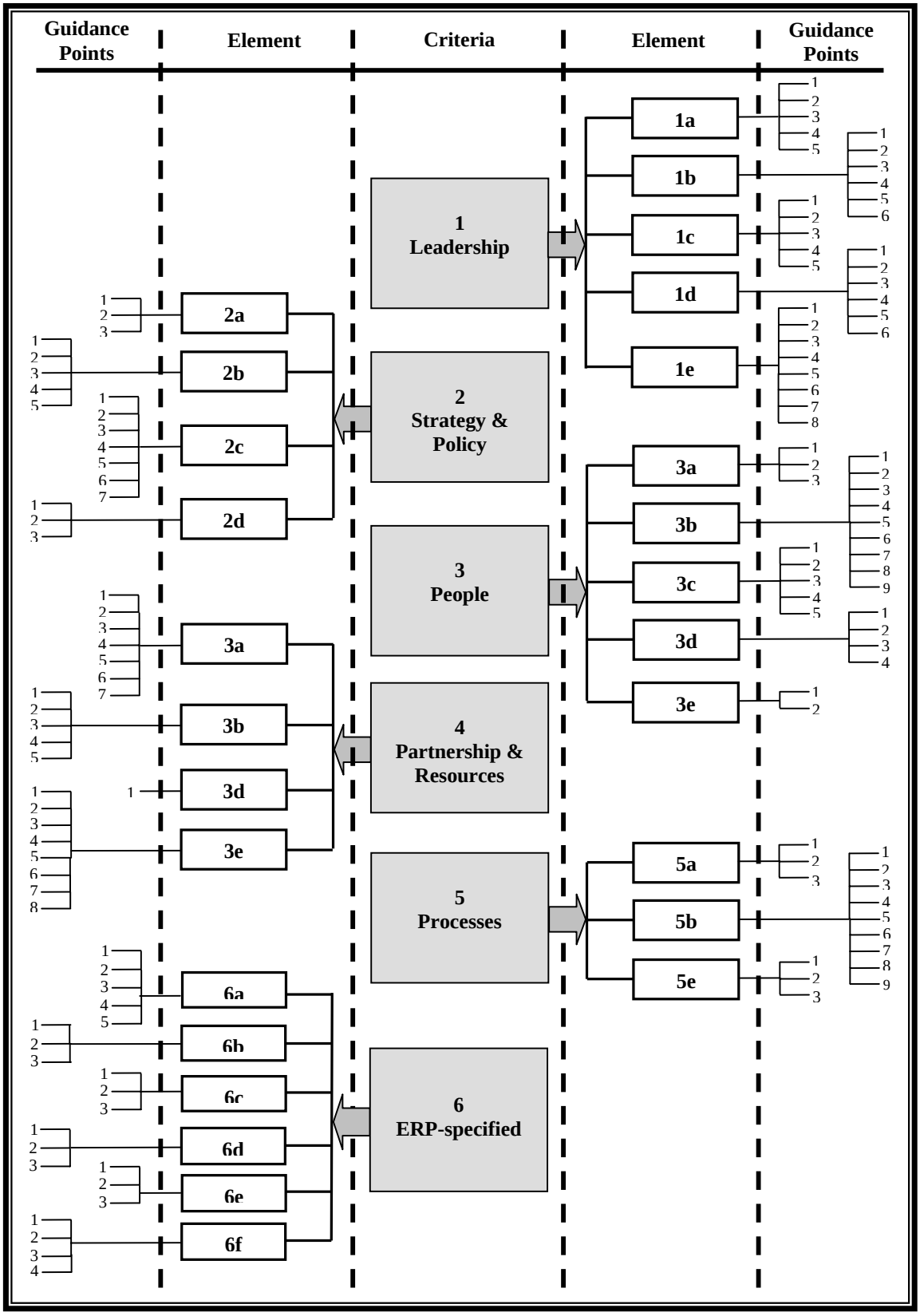

Figure 8: Structure of the proposed model

related to ERP CSFs). The assessment of the first five criteria can be carried out using the EFQM model. In order to assess criteria number 6, a guideline by breaking the criteria into six elements (with subsequent guidelines for scorning each element) were developed. For more details on the list and details of the elements, the readers are referred to Dabiri (2007).

Figure 8 illustrates the structure of the proposed model. It is based on EFQM model which includes ERP specific criteria.

According toTable 5, the proposed model is similar to EFQM model with a modification to include ERP specific CSFs. This model consists of 6 criteria and each one includes a number of elements and guidance points. The number of elements for each criterion is in a range between 3 to 5 and 27 elements in total. In addition, the number of guidance points for each element varies in a range of 26 to 40 and 194 guidance points in total.

In order to specify a detailed set of guidance points for ERP-specified criteria, at first a list of guidance points related to each criterion were prepared by using literature review, mostly based on the works carried out by(Ptak and Schragenheim, 2004; Yusuf et al., 2004; Ehie and Madsen, 2005; Yusuf et al., 2006; Xue et al., 2005; Dabiri, 2007). Then it was sent to the same respondents as shown in Table 3. They were asked to give a score as highly related, very related, related, mildly related and not related. They were also asked to add new guidance points (if any). Having collected the respondent's views, the guidance points for which more than 50% of the respondents gave highly related score or very related were considered as accepted guidance points. Table 6 shows a list of the accepted guidance points.

9. CASE STUDY

In this section, the results of an investigation using the proposed model in a company which manufactures industrial components are presented. The company is equipped with advanced and

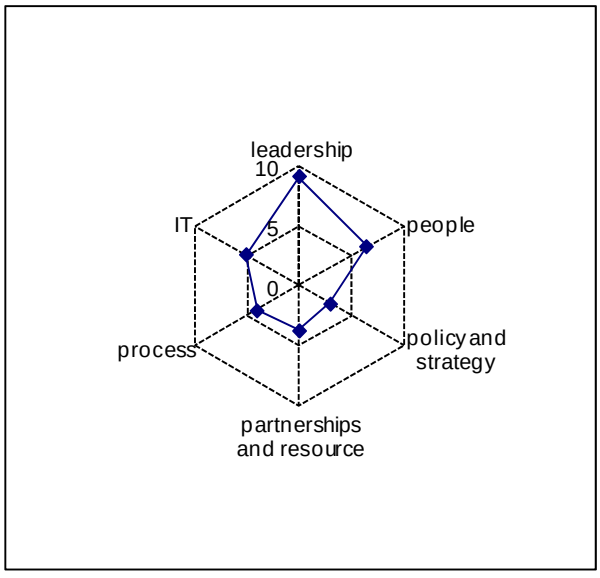

Figure 9: The criteria's scores obtained using the proposed model

mostly CNC machineries. In order to gain the ERP advantage, this company has been investigating the capability of different ERP solutions. However, the management's main concern is whether the company is ready for successful implementation of an ERP system. Since some of the respondents in this research were working as managers or engineers in this company, they agreed to consider the proposed model for assessment. Therefore, the model was first presented to the respondents and then they were asked to give scores to the elements and criteria. Since the company was recently audited by a qualified EFQM auditing company, the scores for the first five criteria of the model were obtained from the EFQM auditing report. It shall be noted that the score for those EFQM elements which have been omitted in the proposed model, were not considered in the assessment. The score for criterion number 6, ERP specific criteria, was also obtained by interview with the respondents. Figure 9 shows the results of the assessment.

The results show that among 6 criteria, leadership has gained the highest score while policy and strategy, partnerships and resources followed by processes obtained the least score. Therefore, in order to improve the company readiness for successful implementation of an ERP system, more attention is needed to improve the criteria with lower scores.

10. DISCUSSION AND CONCLUSION

The results of the investigation presented in this paper confirm a significant relation between ERP CSFs and EFQM enabler's criteria. These results also reveal that a framework similar to EFQM model can be used as a good basis to evaluate the readiness of a company for implementing an ERP system. One of the main advantages in using an EFQM based model is that a structured and well practiced approach developed in EFQM can be applied for the assessment. In addition, the relations between ERP CSFs and EFQM elements, as defined in Table 2 and modified in the paper (see an overview of the modification in Table 4 and for more details refer to Dabiri (2007)), can be used to find the gaps in improving an enterprise readiness for ERP implementation.

In this paper, a model based on EFQM with a focus on ERP CSFs factors was developed. The proposed model has been applied to assess the readiness of a company for successful implementation of an ERP system. The results based on the proposed model and relations between CSFs and EFQM criteria of the company, as described above, are discussed and the following conclusions are in order:

As shown in Figure 9, the results reveal that one of the strength areas of the company is leadership. This can support the ERP project team to act and collaborate effectively while providing them with the required resources. In addition, it can help the management to smoothly apply the changes needed. On the other hand, policy and strategy plus partnership and resources gained the least score. These are related to CSFs such as lack of performance measures determination, in-appropriate resource allocation and un-sustainable ERP implementation. In addition, the processes are given a low score. This may cause inappropriate implementation, lack of documentation and control and may also require process re-engineering. In order to obtain the managers' views, these results were reviewed with the respondents whose views are summarized below.

They agreed with the results obtained in the research in a sense that the company is not ready to implement an ERP system. Beside, they stressed on the following as main gaps in successful implementation of the ERP system:

-The company processes are not mature enough. They need time for stabilizing the processes. The company also requires substantial business process re-engineering before the implementation

project starts. This is in line with the results obtained using the proposed model as process criteria gained a low score.

-Despite a significant competitive improvement of the company within last three years, the company is facing a lack of strategy and policy and hence the interviewers recommended that the company's strategy roadmap to be revised and subsequent organizational changes to be made prior to the implementation of the ERP system. The score obtained for policy and strategy supports such argument.

In addition to the above mentioned reasons, another concern of the managers was lake of successful ERP implementation projects in Iran where the regulations and laws affecting ERP package structures are different from those applied in other countries. During the interview there were only three companies who were implementing SAP, but none of them had completely implemented the package. The managers stated that this is likely to cause the implementation phase to take longer than it is planned and may also cause an increase on the project cost or even results in a failure.

Having reviewed the outcomes of the assessments obtained using the proposed approach and the managers' individual views, it was concluded that the company is not ready to successfully implement an ERP system. Regarding the proposed model, the interviewers remarked that this model can be used to identify the gaps in an enterprise for successful implementation of an ERP system. But the absolute value of the scores obtained for each criterion can not be used as a basis to decide when to implement an ERP system

In general, the results of the investigation presented in this paper reveal that the proposed model is an applicable model and should assist both academicians and practitioners on how to asses the readiness of a firm for successful ERP implementation. This can also assist the managers to focus on the gaps in improving the company's readiness for implementation of an ERP system.

REFERENCES

[1] Abdinnour-Helm S., Lengnick-Hall M.L., Lengnick-Hall C.A. (2003), Pre-implementation attitudes and organizational readiness for implementing an enterprise resource planning system; *European Journal of Operational Research* 146 (2); 258–273.

[2] Akkermans H., Helen K.V. (2002), Vicious and virtuous cycles in ERP implementation: a case study of interrelations between critical success factors; *European Journal of Information Systems* 11; 35–46.

[3] Al-Mashari M., Al-Mudimigh A., Zairi M. (2003), Enterprise resource planning: A taxonomy of critical factors; *European Journal of Operational Research* 146; 352–364.

[4] Baatz E. (1996), Ready or Not; *CIO Magazine*; June 15.

[5] Bancroft N.H., Seip H., Sprengel A. (1998), Implementing SAP R/3., second ed; Manning Publications Co., Greenwich, MA.

[6] Banijamali S.M., Jafarnejad A., Haghparast M. (2005), A framework to assesses the Iranian organizations readiness for ERP implementation; *3rd International Management Conference*; Tehran, Iran.

[7] Bingi P., Sharma M., Godla J. (1999), Critical issues affecting an ERP implementation; *Information Systems Management*; 7–14.

[8] Botta V.G., Millet P.A., Grabot B. (2005a), A survey on the recent research literature on ERP systems; *Computers in Industry* 56; 510–522.

[9] Botta V.G., Millet P.A. (2005b), An investigation into the use of ERP systems in the service sector; *International Journal of Production Economics*; Available on: www.sciencedirect.com.

[10] Botta V.G., Millet P.A. (2005c), A classification for better use of ERP systems; *Computers in Industry* 56; 573–587.

[11] Brown J. (2001), Is ERP a silver Bullet? APICS Online Available http://www.apics.org/magazine/past_issues/2001_01/erp_silver/full/asp.

[12] Buchout S., Frey E., Nemec J. (1999), Making ERP Succeed: Turning Fear Into Promise, Strategy and Business, 2nd Quarter, [Online] Available: http://www.strategy-business.com/technology/99208/.

[13] Chand D., et. al. (2005), A balanced scorecard based framework for assessing the strategic impacts of ERP systems; *Computers in Industry* 56; 558-572.

[14] Dabiri N. (2007), The investigation of enterprise readiness for ERP system implementation; *MSc Thesis*, Faculty of Industrial Engineering, K.N. Toosi University of Technology; Iran.

[15] Davenport T. (1998), Putting the Enterprise into the Enterprise System; *Harvard Business Review, Jul–Aug*; 121–131.

[16] Davenport T. (2000), Mission critical: realizing the promise of enterprise systems; Harvard Business School Press, Boston.

[17] EFQM web page. (2007), www.efqm.org.

[18] Ehie I.C., Madsen M. (2005), Identifying critical issues in enterprise resource planning (ERP) implementation; *Computers in Industry* 56; 545–557.

[19] Gefen D. (2002), Nurturing clients' trust to encourage engagement success during the customization of ERP systems; *Omega* 30; 287–299.

[20] Gyampah K.A., Salam A.F. (2004), An extension of the technology acceptance model in an ERP implementation environment; *Information & Management* 41; 731–745.

[21] Holland C., Light B. (1999), A critical success factors model for ERP implementation; *IEEE Software (May/June)*; 30–35.

[22] Hong K.K., Kim Y.G. (2002), The critical success factors for ERP implementation: an organizational fit perspective; *Information & Management* 40; 25–40.

[23] Hutchins H. (1998), 7 key elements of a successful implementation and 8 mistakes you will make anyway, *APICS, 1998. International Conference Proceedings, Falls Church, VA*; 356–358.

[24] Jones M.C., Cline M., Ryan S. (2004), Exploring knowledge sharing in ERP implementation: an organizational culture framework, Decision Support Systems, Available on: www.sciencedirect.com.

[25] Joshi K., Lauer T.W. (1999), Transition and change during the implementation of computer based manufacturing process planning system: an analysis using the equity implementation model; *IEEE Transactions on Engineering Management* 46; 156–167.

[26] Kale V. (2006), Implementing SAP R/3: The Guide for Business and Technology Managers, Online available: www.uky.edu/IT/AdminApps/IRISTechPortal/Presentations/Chapter1/Implementing%20SAP%20R%20Prest%20Chpt%201.ppt.

[27] King S.F., Burgess T.F. (2006), Beyond critical success factors: A dynamic model of enterprise system innovation; *International Journal of Information Management* 26; 59–69.

[28] Kositanurit B., Ngwenyama O., Osei-Bryson K.M. (2006), An exploration of factors that impact individual performance in an ERP environment: an analysis using multiple analytical techniques; *European Journal of Information Systems* 15; 556–568.

[29] KPMG, 2002. Annual program management survey (2002), Report 203-587, UK: KPMG-LLP.

[30] Kumar V., Maheshwari B., Kumar U. (2002), ERP systems implementation: Best practices in Canadian government organizations; *Government Information Quarterly* 19; 147–172.

[31] Kwon T.H., Zmud W.R. (1987), Unifying the fragmented models of information system implementation; Critical issues in information system research, Wiley, New York.

[32] Lam W. (2005), Investigating success factors in enterprise application integration: a case-driven analysis; *European Journal of Information Systems* 14; 175–187.

[33] Langenwalter G. (2000), Enterprise Resources Planning and Beyond: Integrating Your Entire Organization, St. Lucie Press, Boca Raton, FL.

[34] Lea B-R., Mahesh C.G., Wen-Bin Y. (2005), A prototype multi-agent ERP system: an integrated architecture and a conceptual framework; *Technovation* 25; 433–441.

[35] Liang H., Xue Y. (2004), Coping with ERP-related contextual issues in SMEs: a vendor's perspective; *Journal of Strategic Information Systems* 13; 399–415.

[36] Mabert V.A., Soni A., Venkataramanan M. (2001), Enterprise resource planning survey of US manufacturing firms; *Business Horizon May-June*; 69–76.

[37] Mabert V.A., Soni A., Venkataramanan M. (2003), Enterprise resource planning: Managing the implementation process; *European Journal of Operational Research* 146(2); 302–314.

[38] Mandal P., Gunasekaran A. (2002), Issues in implementing ERP: A case study; *European Journal of Operational Research* 146; 274–283.

[39] Motwani J., Mirchandani D., Madan M., Gunasekaran A. (2002), Successful implementation of ERP projects: Evidence from two case studies; *International Journal of Production Economics* 75; 83–96.

[40] Motwani J., Subramanian R., Gopalakrishna P. (2005), Critical factors for successful ERP implementation: Exploratory findings from four case studies; *Computers in Industry* 56; 529–544.

[41] Nandhakumar J., Rossi M., Talvinen J. (2005), The dynamics of contextual forces of ERP implementation; *Journal of Strategic Information Systems* 14, 221–242.

[42] Nash K.S. (2000), Companies don't learn from previous IT snafus, *Computer-World*, 30.

[43] Ng J.K.C., Ip W.H., Lee T.C. (1999), A paradigm for ERP and BPR integration; *International Journal of Production Research* 37 (9); 108-209.

[44] Nikolaou A.I. (2004), Quality of post-implementation review for enterprise resource planning systems; *International Journal of Account Information System* (5), 25 – 49.

[45] Olhager J., Selldin E. (2003), Enterprise resource planning survey of Swedish manufacturing firms; *European Journal of Operational Research* 146; 365–373.

[46] Oliver R. (1999), ERP is dead! Long live ERP!; *Management Review* 88(10); 12–13.

[47] Olson d. l. (2004), Managerial issues of Enterprise Resource Planning Systems; International ed, McGraw Hill/Irwin, New York, NY.

[48] Ptak C.A., Schragenheim E. (2004), ERP: Tools, Techniques, and Applications for integrating the supply Chain; 2nd ed., St. Lucie Press, New York.

[49] Pui, Ng, C.S., Gable G.G., Chan T. (2002), An ERP-client benefit-oriented maintenance taxonomy; *The Journal of Systems and Software* 64; 87–109.

[50] Rajagopal P. (2002), An innovation-diffusion view of implementation of enterprise resource planning (ERP) systems and development of a research model; *Information & Management* 40; 87–114.

[51] Rao S. (2000), Enterprise resource planning: Business needs and technologies; *Industrial Management & Data Systems* 100(2); 81–88.

[52] Rikhardsson P., Kraemmergaard P. (2006), Identifying the impacts of enterprise system implementation and use: Examples from Denmark; *International Journal of Accounting Information Systems* 7; 36–49.

[53] Sarker S., Lee A.S. (2003), Using a case study to test the role of three key social enablers in ERP implementation; *Information and Management* 40(8); 813–829.

[54] Shang S., Seddon P. (2000), A comprehensive framework for classifying the benefits of ERP systems; *In Proceedings of AMCIS2000* 2; 1005–1014.

[55] Sheu C., Chae B., Yang C-L. (2004), National differences and ERP implementation: issues and challenges; *Omega* 32, 361–371.

[56] Slater D. (1998), the hidden costs of enterprises software; *CIO Enterprise Magazine*, June 15.

[57] Summer M. (1999), Critical success factors in enterprise wide information management systems; *Proceedings of the American Conference on Information Systems, Milwaukee, WI*; pp. 232–234.

[58] Sun A.Y.T., Yazdani A., Overend J.D. (2005), Achievement assessment for enterprise resource planning (ERP) system implementations based on critical success factors (CSFs); *International Journal of Production Economics* 98; 189–203.

[59] Tchokogue A., Bareil C., Duguay C.R. (2005), Key lessons from the implementation of an ERP at Pratt & Whitney Canada; *International Journal of Production Economics* 95; 151–163.

[60] Thomas F., Wallace, Michael H., Kremzar. (2001), ERP: Making it Happen- Implementer's Guide to Success with Enterprise Resource Planning; John Wiley & Sons, Inc.

[61] Umble E.J., Haft R.R., Umble M.M. (2003), Enterprise resource planning: implementation procedures and critical success factors; *European Journal of Operational Research* 146; 241–257.

[62] Wang E., Chou H-W., Jiang J. (2005), The impacts of charismatic leadership style on team cohesiveness and overall performance during ERP implementation; *International Journal of Project Management* 23; 173–180.

[63] Wang E.T.G., Chen J.H.F. (2006), Effects of internal support and consultant quality on the consulting process and ERP system quality; *Decision Support Systems* 42; 1029–1041.

[64] Welti N. (1999), Successful SAP R/3 implementation: practical management of ERP projects. Reading; MA: Addison-Wesley.

[65] Wongnum, P.M., Krabbend, AM J., J., Buhl, H., Ma, X., Kenett, R. (2004), Improving enterprise system support—a case-based approach, *Advanced Engineering Informatics* 18, 241–253.

[66] Xue Y., Liang H., Boulton W.R., Snyder C.A. (2005), ERP implementation failures in China: Case studies with implications for ERP vendors; *International Journal of Production Economics* 97; 279-295.

[67] Yusuf Y., Gunasekaran A., Abthorpe M.S. (2004), Enterprise information systems project implementation: A case study of ERP in Rolls-Royce; *International Journal of Production Economics* 87; 251–266.

[68] Yusuf Y., Gunasekaran A., Wu C. (2006), Implementation of enterprise resource planning in China; *Technovation* 26, 1324–1336.

[69] Zhang Z., Lee M.K.O., Huang P., Zhang L., Huang X. (2005), A framework of ERP systems implementation success in China: An empirical study; *International Journal of Production Economics* 98, 56–80.