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Challenges of ERP implementation: ERP as a Technology Transfer Project

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Abstract. The aim of this study is identifying CSFs of ERP implementation. ERP implementation always deals with challenges which decrease the chances of Implementation success in practice. In order to overcome these challenges, many researchers have applied concepts such as Change Management, Knowledge Management, and Innovation Management to moderate and handle implementation issues; however challenges continue to exist. Thus, we propose a new look into ERP deployment as a Technology, made by a Developer Company, and used by a Recipient Company. In this paper, we see ERP system implementation from a technology transfer perspective. Besides studying ERP, we review models and success factors in Technology Transfer (TT). Then, we summarize Critical Success Factors (CSFs) that integrate the concepts of ERP implementation and TT. A questionnaire based on these CSFs was designed and distributed among four Iranian large companies and their ERP developers. All four of these companies are in heavy metal industry and were implementing an ERP system at the time. Identified CSFs are validated by using T-test, and are categorized by Exploratory Factor Analysis into five main factors. These Factors are: Culture, Organizational Structure, Project Management, Support Activities & Training Issues, and the Interaction between Transferor and Transferee.

Keywords: ERP Implementation, Technology Transfer, Critical Success Factors, Exploratory Factor Analysis

1. Introduction

Today, industrial information systems are mostly implemented through enterprise resource planning (ERP) systems [1]. An ERP system is a modular integrated business software system that facilitates an organization to use its resources efficiently and effectively [2]. ERP is a wide range system that covers all organization levels and enhances all business activities and processes. In fact, ERP systems have increased the productivity of organizational functions by increasing their continuous access to real-time information and enabling them to plan well-timed and efficient. The Integration brought by ERP enables organizations[3] to respond to competitive forces and market opportunities, to improve product portfolio, and to maintain supply-chain relations strictly [4,5].

Many researchers assert that ERP systems are standardized systems, utilizing a single powerful database across the company. This means data should be standardized through the whole company[4,6,7] .Also, ERP deployment necessitates process standardization[8].From a business perspective, ERP-driven reengineering of business processes to company-wide standards is looked to be valuable by managers involved in implementation[9,10]. Although the outstanding advantages of ERP systems have led Companies to move toward adopting them, many have cited failures in ERP implementations [11-14] that invoke attention to the nature of ERP implementation.

ERP Implementing causes massive change that needs to be carefully managed in order to acquire the benefits of an ERP solution. To ensure successful implementation, there are critical issues that must be

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carefully considered [3]. Recent researches (from 2000 until now) have increasingly studied Critical success factors in ERP implementation.

Nah et al., (2001) believe that previous studies of ERP implementation rarely proposed a set of critical success factors. Therefore, they reviewed ten articles that contained either the keyword "success/succeed" or "critical issues/ factors" and the term "ERP" or its' equivalent. In result, they introduced 11 CSFs and classified them into Markus and Tanis's (2000) ERP life cycle[2]. *Aladwani (2001)* claims in implementing ERP systems top managers are faced with user resistance. Therefore he posits an integrated process oriented approach for facing the complex social problems of users' resistance to ERP and suggests to adapt marketing concepts and strategies to ERP context[15]. *Al-Mashari et al., (2003)* state that ERP systems lead to acquiring tangible and intangible benefits. However, these benefits are dependent on the approach adopted for the evaluation, selection and project management of ERP systems. In their opinion, ERP benefits are realized when a close relation is formed between implementation approach and business-wide performance measures [4]. *Kumar et al., (2002)* by studying ERP implementation in government organizations, identify critical management challenges in the ERP implementation activities such as training, upgrading infrastructure, project management, and stabilizing ERP systems[16]. A considerable indication in this research is emphasizing innovation in ERP adoption[17]. *J. Motwani et al., (2005)* argue that an implementation process backed with careful change management, network relationships, and cultural readiness triggers successful ERP implementations. Furthermore, they draw critical factors/issues needed to be considered during stages of the implementation[18]. *E.W.T. Ngai and et al., (2008)* surveyed literature review of CSFs in the implementation ERP across 10 different countries/regions and identified 18 CSFs. They indicate that many companies have faced considerable difficulties implementing huge ERP systems as there is a lack of effective guidance on the implementation of ERP [12]. *Liu (2011)* collated the literature relevant to ERP and Knowledge Management (KM) and integrates the findings to introduce the ERP KM concept. He summarizes the CSFs for ERP KM introduction and surveys the influence of these CSFs on management performance[19].

Researchers have adapted different concepts and approaches to solve problems during ERP implementation. *Some* scholars see ERP as a phenomena that incorporates changes specifically in the areas of culture, business process and organization, and technology [15,20-23]. These changes are challenged by individuals, groups, and even organization structure as they are used to current procedures and conditions and therefore, resist accepting new system. This is the main reason to adapt the Change Management (CM) strategies in ERP implementation. *Other* researchers show that Knowledge Management (KM) is accompanied closely with ERP implementation. They note that ERP is an organizational infrastructure that affects how people work and imposes its own logic on a company's strategy, organization and culture [24]. ERP system is not only a software package to be delivered to an organization but also a set of knowledge (tacit and explicit) that is used by knowledge employees [24-26]. It is essential to identify the existing knowledge and the required knowledge as well as to map a path to fill the gap between current and desired situation; in this case KM concepts is applied. *Yet another group of experts* investigate Innovation aspect of ERP. They believe, Organizations that have successfully adopted ERP systems view them among the most important innovations that have led to the realization of substantial tangible and intangible improvements in a variety of ERP adoption is an innovation in organization process [17]. Innovation Management facilitates the accordance of ERP implementation with implementation objectives through supporting users in training, maintenance, and equipment upgrades [23].

2. ERP Implementation as a Technology Transfer

P. Speser (2006) defines Technology as an aid for conducting an activity which is repeated time and time again[27]. Technology may be a tool, a technique, a material, a skill, a capability, and organizational structure, or knowledge [28]. On the other hand, ERP provides services to all departments in an organization. It provides the enterprise with the capacity to plan and manage its resources based on an approach that aims to integrate processes, functions, and activities in an organization [12,29,30]. Therefore, we investigate ERP as a technology for technology is a composition of technoware (facilities used such as IT infrastructure and ERP software), humanware (abilities to understand capacity for systematic application of knowledge and

human capability such as project manager, expert employees and change agent), orgaware (frameworks and institutions to utilize technoware such as organization structure and procedures, organizational Culture, and standards), and infoware (data, information and scientific knowledge such as system documentations, guidelines, and reports extracted from System) [31].

As we have declared above, we look into ERP as a technology. This technology comes to Receptor Company from a Developer Company; thus, a Technology Transfer (TT) happens. What we here emphasize on is to learn from TT literature and practice to apply in ERP adoption.

TT is the process by which the technology, knowledge, and information developed by a creator is applied and utilized by an applier[32]. The technology transfer process usually involves moving a technological innovation from an R&D organization to a receptor organization [33]. Technology incorporates not only equipment but also know-how and skills [32]; consequently, Transfer term does not just indicate a convey process but also it encompasses ideas such as adoption, possession, and promotion [34]. Success in TT requires understanding of feelings and attitudes in both sides (Transferor and Transferee) that have two sets of different skills, values and priorities [32,35,36].

Calantone et al., (1988), Based on a comparative marketing research concept develops a TT comparative consists mainly of five components (factors) that confine TT process. These factors are: Function, Environment, Actors, Process, and Structure. *C. N. Madu (1989)* focuses on TT from developed countries or multinational corporations to developing countries He suggests a framework that takes a holistic or systematic view of TT and notes how Technology can progress through Research and Development (R&D)[37]. By emphasizing on structural factors, Madu stresses cultural value system to be a CSF in TT [38]. *Simkoko (1992)* focuses on TT in the construction industry of developing countries. In this study, Competence development through TT was carefully observed to determine the influential factors that affect this process. Nevertheless, there are a broad range of competence development benefits described which could be applied to overall value added through TT [39]. *Lin and Berg (2001)* conducted an exploratory study to measure the effect of cultural differences on TT projects. They surveyed a conceptual model in Taiwan's manufacturing companies. Lin and Berg identify three groups of factors: nature of technology; previous international experience; and the cultural difference between the technology provider and receiver[40]. *M. Saad et al., (2002)* attempt to broaden the analysis of the technology transfer phenomenon by focusing research attention on assessing the performance of TT projects and evaluating their success in terms of acceptability to the recipient environment. They assert that TT projects are complex and risky in that they convey a great deal of uncertainty made up of technical, organizational, market, social, political and cultural factors [35]. *A. Reisman, (2005)* believes that Because of TT's multifaceted and multidisciplinary nature, a cross-disciplinary Meta approach is needed to study it as a subject area. He provides a taxonomy or classification of the various TT actors, their motivations, and the modalities of their transactions[41]. *Waroonkun and Stewart (2007)* propose a conceptual model for international TT. The derived structural model consisted of five factors and five paths, representing the interrelationships between the four enabling and one outcome factor. In conclusion, authors argue that Exploratory Factor Analysis and Confirmatory Factor Analysis carried in the research provide some indication that factors addressing technology characteristics, mode of transfer, culture, and training could be included in the model and should be investigated[42]. *Mohamed et al., (2010)* Aim to extract an appropriate conceptual TT model in the context of Libyan oil industry, and focus on literature on modeling of technology transfer in the diverse industry sectors. The result of their research contains TT support, TT infrastructure, TT Environment, and TT Learning Capability as four CSFs.

According to our contribution (ERP as a Technology), we have reviewed current literature and have summarized Critical Success Factors (CSFs) that integrate the concepts of ERP implementation, and TT. Table (1) presents 28 CSFs that we have identified.

3. Data Analysis and Discussion

A questionnaire addressing these CSFs (table1) was designed and distributed among 300 members that were involved in ERP Implementation at four Iranian large companies[1] and their ERP developers. 210 questionnaires were recovered while 199 were effective.

Reliability and validity tests: Reliable validity was established on the contents and wording of the modified questionnaire after the first distribution among experts. After pre-testing, the questionnaire was sent to 32 respondents (top and middle managers). They were asked to score questions in a 7 point Likert item. T-test results indicate that "Appropriate celebration" and "Opening information and communication policy" should be omitted from final questionnaire (p-value for these two factors were above 0.05). The Cronbach is calculated for questions based on the score of the answers provided. In this paper, the reliability of CSFs is 0.788.

In order to determine whether the partial correlation of the variables was small, the authors used the Kaiser–Meyer–Olkin (KMO) and Bartlett's Chi-square test of sphericity before conducting the factor analysis. The result was a KMO of 0.854 and Bartlett test was less than 0.05.

Exploratory Factor Analysis (EFA): EFA technique focuses on underlying constructs of observed phenomena, and attempts to determine structure of observed data. This multivariate technique provides direct insight into the inter-relationships between variables, and empirical support for addressing conceptual issues relating to the underlying structure of the data. It also plays an important complementary role with other multivariate techniques through both data summarization and data reduction. From the data summarization perspective, factor analysis provides the researcher with a clear understanding of which variables may act together and how many variables may actually be expected to have impacts in the analysis. Since in our review of literature we discovered diverse and numerous measures that influence ERP implementation, and our perspective to ERP implementation is novel, we needed a method that addresses our conceptual concerns, and summarizes our findings for researchers and managers who work in this field. This is the reason we have used EFA which is a tool to construct a comprehensive structure in empirical findings.

We used SPSS 19 to analyze data. Table (2) shows EFA result of the identified 26 CSFs, that were grouped into 5 main factors.

Discussion*:* Five main identified factors were determined as follow (table 3):

Table 3- Five main identified factors and their measures

Main Factors	*Measures*
Culture	Change program, Method of Communication, Involving individual and groups, Cultural value system, Motivations
Organization Structure	Top management support, ERP package selection, Standards, BPR, Transfer environment.
Project Management	ERP teamwork and composition, Implementation plan, Project champion, Project characteristics, Supervisory, Corporate and business vision
Training programs and supporting activities	Proper training and education programs, Software configuration, Knowledge capability, Identification of suitable employees
Interaction between Transferor and Transferee	Testing and troubleshooting, Monitoring, performance evaluation, Consulting firms and Vendors, R&D methods, Transferor and transferee characteristics.

Culture refers to elements such as types of formal and informal communications, interactions methods, and assumptions inside a firm. Set of these culture elements shape a value system and determines motivations drivers as well as behavioral attitudes. In this research, attention to culture factor facilitates adoption of ERP as a new technology by developing change programs that involves various individuals and divisions inside the firm.

Organization Structure indicates how activities are done in the firm by determining routines, procedures, and processes, and forms a support system that includes decision making levels, system of reporting and control, and coordinating system. Besides forming selection criteria for the firm top management, this factor can align elements of the organization to the ERP system. Furthermore, this factor emphasizes on the role of top management, and improvement of processes and routines while implementing ERP.

Project management factor consists of considerations and plans for implementing ERP as well as how these considerations and plans are rolled out in line with the firm visions and missions. We claim that

[1] All four of these companies are in heavy metal industry and were implementing an ERP system at the time.

procurement, preparation, and evaluation in the format of project management and introducing project champion can decrease possibilities of the project failure.

Training programs and supporting activities factor, highlights current and needed capabilities and the gap between them and action-plans to fulfill these gaps by focusing on the individual roles.

Interaction between Transferor and Transferee factor considers the collaborative activities between the vendor and the client firm in different phases of ERP implementations. Tasks such as ERP software development, troubleshooting, monitoring, performance evaluation and Consulting are accomplished when an effective relationship among actors of ERP implementations is established.

4. Conclusion

In this paper, we see ERP system implementation from a technology transfer perspective. We identified Critical Success Factors (CSFs) that integrate the concepts of ERP implementation and TT. A questionnaire based on these CSFs was designed and distributed among four Iranian large companies and their ERP developers. Based on EFA, 26 identified and validated CSFs were clustered into five main Factors. These five factors are named: Culture, Organizational Structure, Project Management, Support Activities & Training Issues, and the Interaction between Transferor and Transferee. As we presented in this paper, through learning from TT literature review and practice, we can find a set of main factors that decrease complicated challenges in ERP implementation and increase success chance of implementation.

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Table 1- 28 CSFs identified

No.	**CSFs in ERP implementation**	**References**
H1	Change program	F. Nah and J. Lau 2001, M. Aladwani 2001, V. Kumar et al., 2002, E.W.T. Ngai et al., 2008,
H2	Method of Communication	M. Aladwani 2001, M. Saad et al., 2002, Mohamed et al 2010
*	Appropriate celebration	J. Motwani et al., 2005;
H3	Involving individual and groups	M. Aladwani 2001; M. Saad et al., 2002; E.W.T. Ngai et al., 2008; Sanchez & Perez, 2007
H4	Cultural value system	C.N. Madu 1989; F. Nah and J. Lau 2001
H5	Motivations	A. Reisman, 2005; Mohamed et al 2010
H6	Top management support	F. Nah and J. Lau 2001; M. Aladwani 2001; Sanchez & Perez, 2007; P.Liu 2011
H7	ERP package selection	C.N. Madu 1989; V. Kumar et al., 2002; Al-Mashari et al., 2003; J. Motwani et al., 2005; E.W.T. Ngai et al., 2008;
H8	Standards	J. Motwani et al., 2005; A. Reisman, 2005; Mohamed et al 2010
H9	BPR	Simkoko, 1992; F. Nah and J. Lau 2001; E.W.T. Ngai et al., 2008; P.Liu 2011;
H10	Transfer environment	F. Nah and J. Lau 2001; Lin and Berg, 2001; J. Motwani et al., 2005; Waroonkum and Stewart, 2007; E.W.T. Ngai et al., 2008; Mohamed et al 2010;
H11	ERP teamwork and composition	Simkoko, 1992; F. Nah and J. Lau 2001; V. Kumar et al., 2002; J. Motwani et al., 2005; Sanchez and Perez, 2007; Mohamed et al 2010
H12	Implementation plan	Simkoko, 1992; F. Nah and J. Lau 2001; Al-Mashari et al., 2003; J. Motwani et al., 2005; E.W.T. Ngai et al., 2008; A. Reisman, 2005; Mohamed et al 2010
H13	Project champion	F. Nah and J. Lau 2001; Sanchez and Perez, 2007; E.W.T. Ngai et al., 2008;
H14	Project characteristics	Calantone et al. 1988; Simkoko, 1992; Lin and Berg , 2001; M. Saad et al., 2002; E.W.T. Ngai et al., 2008; Mohamed et al 2010
H15	Supervisory	C.N. Madu 1989; M. Saad et al., 2002; Al-Mashari et al., 2003; E.W.T. Ngai et al., 2008; Mohamed et al 2010
H16	Corporate and business vision	C.N. Madu 1989; F. Nah and J. Lau 2001; Al-Mashari et al., 2003; A. Reisman, 2005; E.W.T. Ngai et al., 2008 ; P.Liu 2011
H17	Proper training and education programs	C.N. Madu 1989; V. Kumar et al., 2002; Al-Mashari et al., 2003; Waroonkum and Stewart , 2007; Mohamed et al 2010; P.Liu 2011
H18	Software configuration	Al-Mashari et al., 2003; V. Kumar et al., 2002;
H19	Knowledge capability	C.N. Madu 1989; E.W.T. Ngai et al., 2008; Mohamed et al 2010;
*	Opening information and communication policy	M. Aladwani 2001; J. Motwani et al., 2005;
H20	Identification of suitable employees	Al-Mashari et al., 2003 ; V. Kumar et al., 2002; P.Liu 2011
H21	Testing and Troubleshooting	F. Nah and J. Lau 2001; Al-Mashari et al., 2003; V. Kumar et al., 2002; E.W.T. Ngai et al., 2008
H22	Monitoring	Calantone et al. 1988; F. Nah and J. Lau 2001; E.W.T. Ngai et al., 2008;
H23	performance evaluation	Simkoko, 1992; F. Nah and J. Lau 2001; E.W.T. Ngai et al., 2008;
H24	consulting firms and Vendors	Calantone et al. 1988; A. Reisman, 2005; Mohamed et al 2010; P.Liu 2011
H25	R&D methods	Calantone et al. 1988; C.N. Madu 1989; F. Nah and J. Lau 2001; E.W.T. Ngai et al., 2008
H26	Transferor and transferee characteristics	Calantone et al. 1988; Sanchez and Perez, 2007; Waroonkum and Stewart , 2007; Mohamed et al 2010
*these two CSFs were omitted due to their *p-value*		

Table 2 - Factor Analysis Results

CSFs	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	23.947	27.793	27.793	23.580	27.367	27.367
2	16.163	18.758	46.551	13.635	15.825	43.192
3	13.491	15.657	62.209	13.805	16.022	59.214
4	13.017	15.107	77.316	15.445	17.925	77.139
5	7.877	9.142	86.458	8.030	9.320	86.458
6	2.523	2.928	89.387			
7	1.477	1.714	91.101			
8	1.116	1.295	92.395			
9	.966	1.121	93.517			
10	.867	1.006	94.523			
11	.720	.835	95.358			
12	.592	.687	96.045			
13	.544	.631	96.676			
14	.461	.535	97.211			
15	.427	.496	97.707			
16	.386	.449	98.156			
17	.367	.426	98.581			
18	.307	.356	98.938			
19	.265	.308	99.245			
20	.225	.261	99.507			
21	.177	.205	99.712			
22	.134	.155	99.867			
23	.114	.133	100.000			
24	Ɛ[1]	Ɛ	100.000			
25	Ɛ	Ɛ	100.000			
26	Ɛ	Ɛ	100.000			

[1] Ɛ has a little value