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The Role of Absorptive Capacity in the Usage of a Complex Information System: The Case of the Enterprise Information System

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Abstract: The purpose of this study is to model the relationship between absorptive capacity and intention to use in the Enterprise Resource Planning (ERP) environment in Iran. This research is a correlation study where a field survey was employed for data collection. The unit of analysis is Iranian individuals who are ERP user in organizations using ERP systems. The questionnaires were sent to the selected organizations. Using a structural equation modeling analysis we tested the hypothesized relationship using AMOS version 16.0. The results indicate that all three absorptive capacity measures to be good predictors of intention to use. Absorptive capacity for applying was the strongest predictor followed by absorptive capacity for understanding and absorptive capacity for assimilating. When implementing complex information systems, managers must also look at the absorptive capacity of the users in order to successful implementation of the system and to ensure continued usage. Previous researchers have not looked at the role of absorptive capacity in system usage at the same rate as those related to technology acceptance research which only focuses on the ease of use and usefulness. Thus this research adds on to the existing literature where future researchers may want to expand on the factors that may influence absorptive capacity for further policy implications.

Keywords: absorptive capacity for understanding, absorptive capacity for assimilating, absorptive capacity for applying, SEM, ERP, Iran
Categories: H.1.1, H.1.2, H.2.4, H.3.4, H.4.2

1 Introduction

Rapid growing technology has influenced individuals and societies' interactions for decades [Youngberg, Olsen, and Hauser 2009]. Competitive business environment and globalization force organizations to seek new ways to sustain in the market. In the meantime, making effective decisions is not possible without effective information systems which enable managers to have the right information at the right time [Zabjek, Kovacic, and Stemberger 2009]. Enterprise resource planning (ERP) systems

are the most powerful enterprise information systems as they are organizational wide and useful tools to improve performance and achieve competitive advantages [Amoako-Gyampah and Salam 2004].

ERP is software system for business management which integrates information and processes among different functional departments and support areas [Haag and Cummings 2008]. ERP integrates operations in different departments or enhance the existing integration which leads to cost reduction, inventory decline and business processes improvement via transferring best business practices. ERP market continues to grow at an annual growth rate of 11 percent by 2011 [Zabjek et al. 2009]. ERP providers target all companies all over the world of different sizes [Haag and Cummings 2008]. Therefore, there is a guarantee that ERP continues to be the largest, fastest-growing, and most influential player in the application software industry in the next decade [Zabjek et al. 2009].

While organizations are spending considerable amount of money on implementing ERP systems, researchers are discussing about the low rate of usage among potential users [Calisir & Calisir 2004]. ERP failure rate has reported to exceed 50 percent [Youngberg et al. 2009]. Without technology acceptance, users use system as minimum as they need to enter/store necessary data for their daily tasks but not to explore its full features to achieve desired goals which lead to competitive advantage [Youngberg et al. 2009]. Practical efforts to find ways for more effective and successful implementation of ERP systems should be accompanied by discovering new methods to enhance the ERP systems' acceptance by users while increasing their intention to use [Bueno and Salmeron 2008].

The importance of ERP users' acceptance in organizations has been discussed in many studies as one of the most significant factors for successful implementation [Hwang, 2005; Wang & Chen, 2006; Wang, Shih, Jiang, and Klein 2008]. Large systems development requires users' input in order to be successful while lack of their support may hinder successful implementation [Wang et al. 2008]. Therefore, ERP systems need users to feed them operational data to operate properly and to be able to provide right output in right time for managers. Even if an ERP is technically acceptable but if it is not fully used by organization's users, the firm will not get the desired goals and benefits from the expensive investment for implementing ERP [Amoako-Gyampah and Salam 2007]. Another study by [Magni and Pennarola 2008] mentioned that the strategic value of IT investments can be accomplished when potential users accept it.

[Amoako-Gyampah and Salam 2004] argued that usage of ERP system includes mandatory and voluntary usage. They mentioned that mandatory usage differs from voluntary in some aspects. In the mandatory usage, users use ERP as minimum as it is needed to perform their daily tasks and resist using ERP, whereas voluntary usage is beyond the mandatory usage. They also argued that in both situations, organizations would benefit from ERP usage. [Zabjek et al. 2009] noted that increase in usage will lead to increase in successful ERP implementation. [Chien and Tsaur 2007] mentioned that user satisfaction and values of ERP systems to the organization can be further realized only after effective usage of ERP systems and achieving their benefits.

Firms with more capabilities to acquire and exploit new knowledge have superior innovation and performance which leads to competitive advantages [George, Zahra, Wheatley, and Khan, 2001; Escribano, Fosfuri, and Tribó 2009; Easterby-Smith,

Graça, Antonacop, & Ferdinand, 2008; Jansen, Bosch, and Volberda 2005]. To get a great result from ERP implementation, ERP systems should transfer the embedded knowledge to the recipient organization. As ERP systems are very complicated, absorbing their embedded knowledge is challenging; yet the quality of knowledge transfer is also crucial. Therefore, source and the recipient companies should have the needed capabilities. According to [Xu and Ma 2008], both source and recipient firms' absorptive capacity are important factors in knowledge transfer process.

2 Literature review and hypotheses generation

The concept of absorptive capacity was first defined by [Cohen and Levinthal 1990] as 'the ability of an organization member to value, assimilate and apply new external knowledge to the commercial ends'. [Zahra and George 2002], followed [Cohen and Levinthal 1990] and examined absorptive capacity at the organization level. They defined the construct of absorptive capacity in two different categories, potential and realized with each of them can differentially influence the creation and sustenance of competitive advantage in the firm. Dynamic aspect of absorptive capacity is further revealed by these dimensions [Harrington & Guimaraes 2005]. [Zahra and George 2002] introduced four phases for absorbing external knowledge which are acquisition, assimilation, transformation and exploitation. Acquisition and assimilation of knowledge are defined under potential absorptive capacity while transformation and exploitation are under realized absorptive capacity. Potential absorptive capacity is referred to a firm's receptiveness to external knowledge and realized absorptive capacity is related to a firm's capacity to leverage absorbed knowledge and transform it into innovation outcome [Fosfuri and Tribó 2008]. [Jansen et al. 2005] also followed [Zahra and George 2002] dimensions of absorptive capacity in their study.

Absorptive capacity improves the speed, frequency, and magnitude of innovation and enhances learning within an organization [Deng, Doll, and Cao 2008]. Some previous studies discussed that prior accumulated knowledge improves firm's absorptive capacity [Davidson and Olfman, 2004; George et al., 2001; Szulanski 1996]. [Park et al. 2007] explained absorptive capacity as skills needed to deal with the components of transferred knowledge and it is required to adopt this imported knowledge.

According to [Kraaijenbrink and Wijnhoven 2008] absorptive capacity attempt to answer how organizations acquire and use external knowledge to innovate. They mentioned that absorptive capacity is more instrumental than the other concepts while focusing on the newness and commercial application of knowledge as a source of innovation.

[Cohen and Levinthal 1990] used R&D spending as measure of absorptive capacity. [George et al. 2001] extended this measurement by using it as a proxy for a firm's absorptive capacity [George et al., 2001]. In [Park et al. 2007], three dimensions are defined for absorptive capacity in the ERP environment which are absorptive capacity for understanding, absorptive capacity for assimilating and absorptive capacity for applying ERP systems. Individuals are the main agents of learning and change and organizations learn through their individual members [Deng

et al., 2008]. Therefore, in this study, we study absorptive capacity at the individual level.

[Park et al. 2007] asserted that users' absorptive capacity impact their performance of ERP usage, as if they fail to understand the concept and functions of the system, their usage gives minimum benefits and outcomes to the organization. [Agarwal and Karahanna 2000] defined cognitive absorption as a conceptual construct that captures the totality of an individual's experience with new software and they argued that cognitive absorption is the antecedent of the two dominating technology acceptance factors which are perceived usefulness and perceived ease of use (core constructs of Technology acceptance Model (TAM)) in the information technology context. [Zhang, Li and Sun 2006] also hypothesized and empirically confirmed the same results for their target technology which was a university website. Both of these studies examined the indirect effect of cognitive absorption on intention to use technology.

[Upadhyay and Dan 2008] argued that firms with strong absorptive capacity would have better information system performance. [Deng et al. 2008] also empirically tested among individuals engaged in IT enabled engineering work that the greater an individual's absorptive capacity, the more extensively IT is used for problem solving and decision support. According to [Park et al. 2007], in the context of ERP environment, absorptive capacity for understanding is referred to users' acquired knowledge of ERP system and consultants involved in project implementation. The next step is assimilating the external knowledge which includes internalizing the knowledge to perform routine tasks using technology and the extent the users feel comfortable using the technology. Finally, individual's knowledge will not be useful unless they exploit it to the commercial ends and for problem solving which is applying the acquired knowledge.

Therefore, it is expected that when individuals have prior knowledge about ERP, they feel more familiar to it which encourage them to use it. Furthermore, if they assimilate and apply ERP knowledge, it is predicted that they further use it. Thus, in this study, it is hypothesized that absorptive capacity for understanding, assimilating and applying ERP systems influences individuals' intention to use ERP. Hence, the following hypotheses were proposed.

H_1: Absorptive Capacity for Understanding would positively influence intention to use the ERP system

H_2: Absorptive Capacity for Assimilating would positively influence intention to use the ERP system

H_3: Absorptive Capacity for Applying would positively influence intention to use the ERP system

The research model for this paper is developed based on the literature and interviews with practitioners (Fig. 1.)

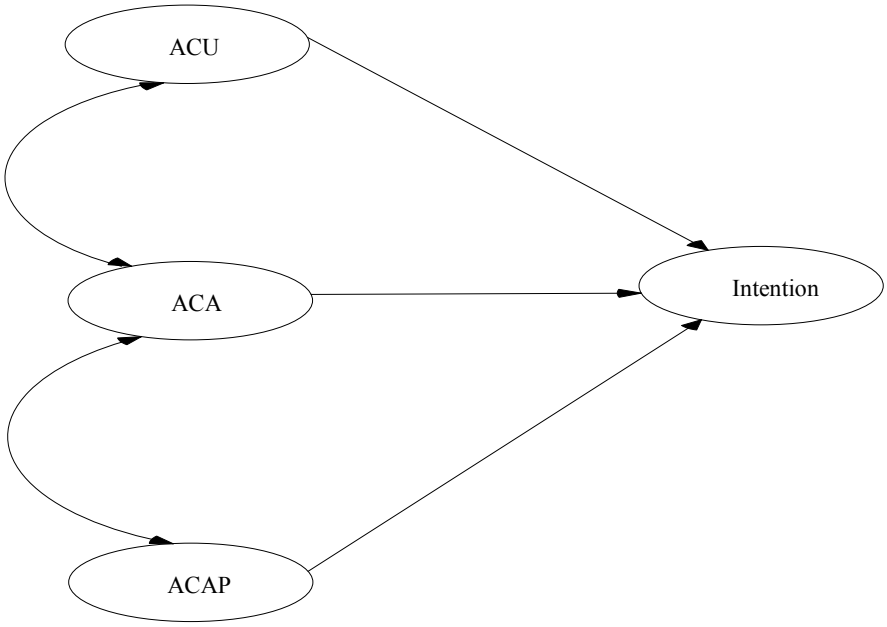

Figure1: Research Model

3 Methodology

This research is a correlation study where a field survey was employed to gather data to test the hypotheses generated. It is a cross sectional research as data was gathered at one point of time and it is conducted in a normal setting without any form of influence on the respondents of the study. The unit of analysis is Iranian individuals who are working in an organization that has implemented or is in the process of implementing ERP system. They are ERP users and use ERP to perform their daily tasks. The researchers used purposive sampling method. Two Iranian ERP solution providers and Iran ERP Association cooperated in this study. They distributed the questionnaires to their customers who are using their ERP systems. The detailed questionnaire is presented in Appendix A. Data was collected in 2010. Totally, 184 questionnaires were used for the analysis.

Among 184 respondents, 72 (39.1%) of the respondents were male and 112 (60.9%) were female. The age range composition of respondents consists of 15 (8.2%) of them were under 25, 81 (44.0%) between the ages of 25-29, 51 (27.7%) between the ages of 30-35, 24 (13.0%) between the ages of 36-39, 8 (4.3%) between 40-45 and 4 (2.2%) were above 45. One did not reveal her age. There were 90 (48.9%) support staff / non-executive staff /administrative, 62 (33.7%) professional staff / supervisor / leader / engineer, 22 (12.0%) middle management, 10 (5.4%) top management. The educational levels of the respondents consists of 17 (9.2%) certificate / diploma, 49 (26.6%) associate's degree, 82 (44.6%) with bachelor degree, 30 (16.3%) with

master's degree and 6 (3.3%) with PhD. Among the respondents 143 (77.7%) did not have prior experience using ERP systems while 41 (22.3%) had experience.

The questionnaires distributed in both governmental and private sector that 44 (23.9%) of the respondents were from government sector while 137 (74.5%) of them were from private sector and 3 (1.6%) of them were working in both (having more than one job at the time is common in Iran). The income level of respondents also was asked in the questionnaire where 86 (46.7%) of the respondents had income level less than $600, 46 (25.0%) had income between $600-$900, 21 (11.4%) had between $900-$1200, 9 (4.9%) had between $1200-$1500, 13 (7.1%) of them get salaries above 1500$ and 9 (4.9%) of the respondents did not reveal about their income level.

4 Results

a. Descriptive statistics

Means, standard deviation, and ranges for the constructs used in this research are presented in Table 1. The intercorrelation among the constructs is presented in Table 2. All constructs were significantly correlated at the 0.01 level except for absorptive capacity for understanding and assimilating was not correlated.

Constructs	Min	Max	Mean	Std. Dev.
Absorptive Capacity for Understanding	1	7	3.81	1.78
Absorptive Capacity for Assimilating	1.25	7	5.21	1.29
Absorptive Capacity for Applying	1	7	5.06	1.35
Intention to Use	1	7	5.45	1.48

Table 1: Descriptive Statistics

Constructs	(1)	(2)	(3)	(4)
Absorptive Capacity for Understanding	1.000			
Absorptive Capacity for Assimilating	.042	1.000		
Absorptive Capacity for Applying	.231**	.444**	1.000	
Intention to Use	.321**	.368**	.512**	1.000

**p < 0.01

Table 2: Intercorrelations of the main variables

b. Measurement Model

We ran a full confirmatory factor analysis (CFA) including a criterion variable which is intention to use to test the validity and reliability of the measures adopted. The results are presented in Table 3. First we tested the convergent validity which is the degree to which multiple attempts to measure the same concept is in agreement. As suggested by [Hair et al. 2010] we used the factor loadings, composite reliability and average variance extracted to assess convergence validity. The loadings for all items exceeded the recommended value of 0.6 [Hair et al. 2010]. Composite reliability values, which depict the degree to which the construct indicators indicate the latent, construct, ranged from 0.818 to 0.939 which exceeded the recommended value of 0.7 [Hair et al. 2010]

		Convergent validity		
Construct	Item	Factor Loading	CR[a]	AVE[b]
Absorptive Capacity for Understanding	ACU2	0.655	0.910	0.672
	ACU3	0.898		
	ACU4	0.888		
	ACU5	0.810		
	ACU6	0.824		
Absorptive Capacity for Assimilating	ACA1	0.513	0.818	0.538
	ACA2	0.708		
	ACA3	0.857		
	ACA4	0.808		
Absorptive Capacity for Applying	ACAP1	0.724	0.879	0.593
	ACAP2	0.750		
	ACAP3	0.871		
	ACAP4	0.758		
	ACAP5	0.740		
Intention to Use	BIU1	0.875	0.939	0.836
	BIU2	0.912		
	BIU3	0.955		

Note: ACU1, ACA5, ACA6 and ACA7 were deleted due to low loading
CR = Composite Reliability, AVE = Average Variance Extracted

Table 3: Result of CFA for measurement model

The average variance extracted, which reflects the overall amount of variance in the indicators accounted for by the latent construct, were in the range of 0.538 and 0.836 which exceeded the recommended value of 0.5 [Hair et al. 2010]. Next we proceeded to test the discriminant validity. Discriminant validity can be examined by comparing the squared correlations between constructs and variance extracted for a

construct [Fornell and Larcker 1991]. As shown in Table 4, the squared correlations for each construct is less than the square root of the average variance extracted by the indicators measuring that construct indicating adequate discriminant validity. In total, the measurement model demonstrated adequate reliability, convergent validity and discriminant validity.

Constructs	(1)	(2)	(3)	(4)
(1) AC for Understanding	**0.820**			
(2) AC for Assimilating	0.002	**0.733**		
(3) AC for Applying	0.053	0.197	**0.770**	
(4) Intention to Use	0.103	0.135	0.263	**0.914**

Note: Diagonals represent the square root of the average variance extracted while the other entries represent the squared correlations

Table 4: Discriminant validity of constructs

c. Structural Model

The structural model was estimated using the maximum likelihood estimate (MLE) using the AMOS software version 16. As presented in Table 5, the test of the overall model fit yielded a $\chi^2 = 267.239$ with 113 degrees of freedom and a p-value of less than 0.001. Although this suggest a not very good absolute fit, many researches also report a number of other relative fit of the data to the model. All the fit indices were above the recommended values except for the Goodness-of-fit index (GFI) which was slightly below the 0.90 cutoff. The Adjusted goodness-of-fit (AGFI) was 0.820, Comparative Fit Index (CFI) was 0.932, the Tucker-Lewis Index (TLI) was 0.918 and the Root Mean Square Error of Approximation (RMSEA) which measures the discrepancy per degree of freedom [Steiger and Lind, 1980] was 0.08. [Gerbing and Anderson 1992] identified CFI as one of the most stable and robust fit indices. As such we can conclude that the research model developed fits the data quite well based on the various recommended values gleaned from the literature.

Fit Index	This Study	Recommended values	Source
Df	113		
χ^2	267.239		
χ^2/df	2.365	≤ 3.00	Gefen (2000)
GFI	0.867	≥ 0.90	Hoyle (1995)
AGFI	0.820	≥ 0.80	Chau & Hu (2001)
CFI	0.932	≥ 0.90	Bagozzi & Yi (1988)
RMSEA	0.08	≤ 0.10	Browne and Cudeck (1993)
NNFI (TLI)	0.918	≥ 0.90	Bagozzi & Yi (1988)

Table 5: Structural Model Fit Indices

d. Path Coefficients and Explanatory Power

Table 6 and Fig. 2 present the detailed results of the structural model. As shown in Fig. 2, the explanatory power of the model was 0.40 which means 40% of the variation in intention to use the ERP system can be explained by the 3 variables. All three absorptive capacity measures were significantly related to intention to use, with ACU ($\beta = 0.24$, $p < 0.01$), ACA ($\beta = 0.21$, $p < 0.01$) and ACAP ($\beta = 0.40$, $p < 0.01$). Absorptive capacity for applying was the most influential predictor followed by capacity to understand and then only capacity to assimilate. Thus all 3 hypotheses, H1, H2 and H3 were supported.

	Relationship	Coefficient	C.R.	p-value	Supported
H1	ACU → Intention	0.24	3.572	0.000	YES
H2	ACA → Intention	0.21	2.605	0.009	YES
H3	ACAP → Intention	0.40	4.715	0.000	YES

Table 6: Path coefficients and hypothesis testing

5 Discussion

It is further emphasized in this study that absorptive capacity in ERP environment has three dimensions which are absorptive capacity for understanding, assimilating and applying new knowledge. This would help future researchers to have a precise measurement for absorptive capacity in ERP environment. The mentioned three factors of absorptive capacity are in line with initial definition of absorptive capacity by [Cohen and Levinthal 1990]. Park et al. also empirically verified these separate components of absorptive capacity in ERP environment. However, [Zahra and George 2002] examined absorptive capacity in different unit of measurement (organization level) and found four dimensions for absorptive capacity which have one more dimension named transformation which happens before exploitation phase.

The important role of absorptive capacity on predicting intention to use complied with prior similar studies [Agarwal & Karahanna, 2000; Xu & Ma, 2008; Zhang et al., 2006]. Our results also implied that among three absorptive capacity components for understanding, assimilating and applying ERP, the absorptive capacity for applying ERP is the most important component to influence intention to use which means some people may find ERP complicated yet difficult to understand about it unless they experience it directly. This is expected since the use of ERP systems is mandated. With this direct usage they can have a clear understanding about the ERP. [Park et al. 2007] also found that absorptive capacity for applying ERP is the most important component in performance of ERP usage. They further discussed about the importance of cumulative prior knowledge which lead to more effective assimilation and application of new knowledge.

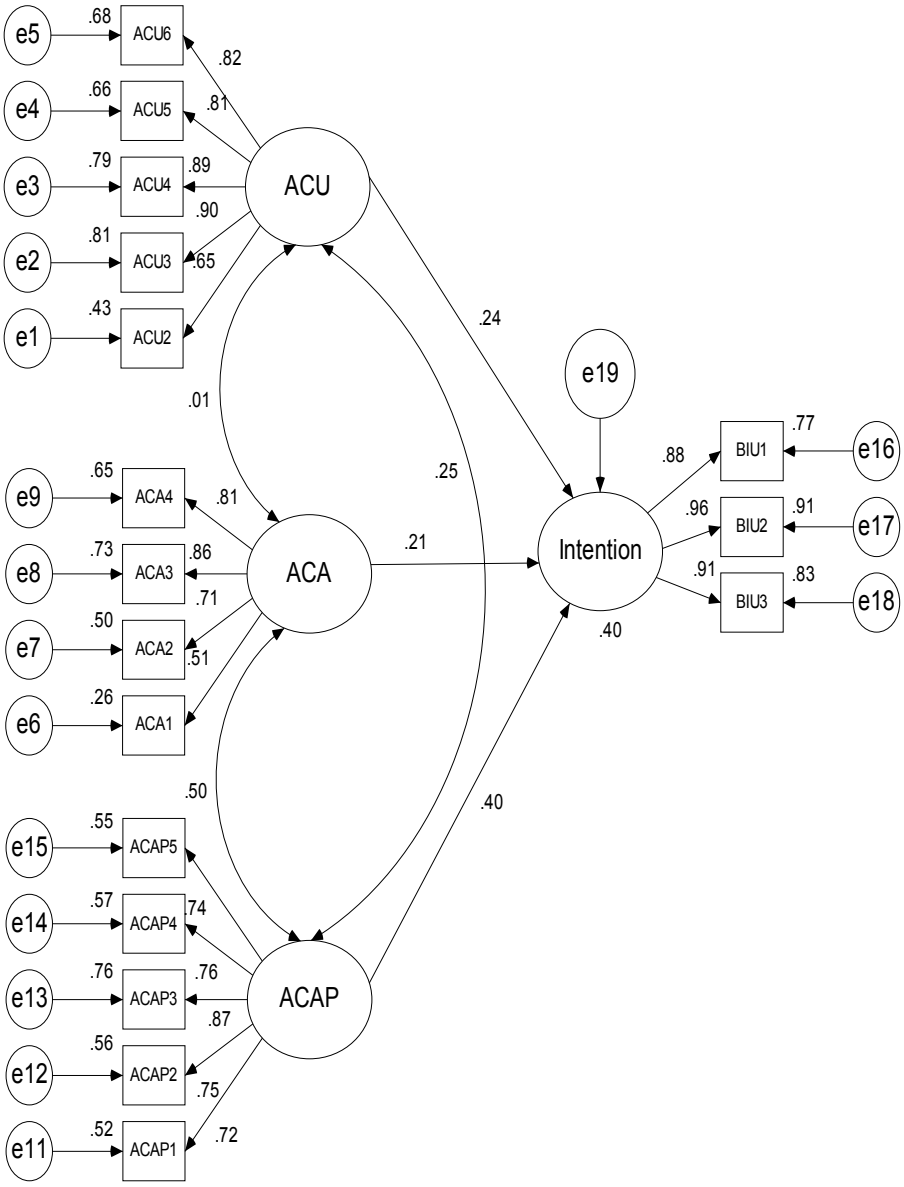

Figure 2: Structural Model

6 Contributions and limitation

This paper contributes to the literatures on absorptive capacity as it is the first empirical evidence that demonstrates the relationships between the individuals' absorptive capacity and intention to use ERP systems. In terms of contribution to practitioners, absorptive capacity for applying ERP is found the most important component for overall individuals' absorptive capacity to influence their intention to use ERP. Therefore, Iranian firms should make extra efforts in order to teach ERP functions to the ERP users in a way that they apply it in their daily tasks. Iranian organizations also need to accumulate sufficient prior knowledge of ERP systems in advance of ERP adoption. It is suggested that only prior knowledge which is acquired through experiencing ERP is useful not only prior knowledge about ERP concepts.

Consultants can help clients acquire the needed knowledge for a successful implementation through guided learning, formal training, and other knowledge creation activities [Wang et al. 2007]. As suggested by [Park et al. 2007], in many cases, recipient firms tended to implement ERP adoption in two steps which the initial step is from ERP consultants to the most knowledgeable task force team members and after that from these knowledgeable users to others in the organization.

Clear understanding of ERP's capabilities and functions would improve users' knowledge and consequently increases their intention to use. Assistance of users especially early in implementation process would lead users to use ERP. Once individuals found that interacting and working with ERP is not a big deal and not scary, they would continue using it. According to [Wang et al. 2007], firms differ in their capability to absorb and assimilate new inputs of the ERP system and a firm with more internal knowledge stock will have a greater successful ERP implementation. Therefore, Iranian ERP adopting firms should strengthen their internal knowledge stocks in order to enhance the flow of knowledge transfer.

The results of this study are subject to some limitations to generalize the results. Conclusions drawn in this study are based on a single technology which is ERP software and the result may differ for other technologies. Furthermore, data was only collected at one point of time, therefore as it is a cross-sectional study it is probable that the results may be different in different phases of ERP implementation and in future.

Furthermore, the potential for common method variance should be taken into account. Data were analyzed in this research, collected from Iranian individuals and the results may be different in other countries. Furthermore, data collected in organizations which implemented Iranian ERPs, the result may be different if data were gathered in organizations which implemented foreign solutions. In addition, majority of data collected from two Iranian ERP producers' customers were asked to participate in the study, thus the results may vary if other ERP producers' customers were included as well.

On the other hand, in the view of the research model and variables studied, due to sampling issues and considering parsimoniously of the research due to time constraints, intention to use ERP system was examined while the actual usage may be different. However, and some other authors mentioned that behavioral intention is a good predictor for actual usage.

In addition, the model is not perfect (R^2 is not 1), thus it could be some other antecedent variables determining variation on intention to use. It can be age, gender, educational level, prior experience and cultural differences.

7 Conclusion

In this study, we examined the role of absorptive capacity in three dimensions, based on [Cohen and Levinthal 1990] definition and [Park et al. 2007] study in ERP environment, on intention to use ERP systems among Iranian ERP users in Iranian organizations. We found all three main components of absorptive capacity which are absorptive capacity for understanding, assimilating and applying ERP systems influence users' intention to use ERP systems. In addition, absorptive capacity for applying ERP has found to have the highest impact on intention to use ERP systems.

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Appendix A

Absorptive Capacity for Understanding (ACU)							
I knew the general concept and functions of the ERP system before my company adopted it	1	2	3	4	5	6	7
I knew the specificities on the module that I currently use before my company adopted the ERP system	1	2	3	4	5	6	7
I knew the reputations of the ERP consulting firm before my company adopted the ERP system	1	2	3	4	5	6	7
I knew the careers and reputations of the ERP consultants before my company adopted the ERP system	1	2	3	4	5	6	7
I knew the deliverables the ERP consulting firm would provide before my company adopted the ERP system	1	2	3	4	5	6	7
I knew the after-sales services that the ERP consultants would provide before my company adopted the ERP system	1	2	3	4	5	6	7
Absorptive Capacity for Assimilating (ASA)							
I can use ERP very well if I have only software manuals for reference	1	2	3	4	5	6	7
I can use ERP very well if I can call someone else to solve my problems	1	2	3	4	5	6	7
I can use ERP very well if someone helps me get started	1	2	3	4	5	6	7
I can use ERP very well if I had a lot of time	1	2	3	4	5	6	7
I am qualified enough to perform tasks using ERP	1	2	3	4	5	6	7
I have the capability to achieve the objectives of tasks by using ERP	1	2	3	4	5	6	7
I have superior skills and capabilities to perform tasks using ERP compared to other colleagues	1	2	3	4	5	6	7
Absorptive Capacity for Applying (ACAP)							
I can apply the knowledge derived from ERP to my tasks	1	2	3	4	5	6	7
I can apply the advanced processes derived from ERP to my tasks	1	2	3	4	5	6	7

I can share knowledge derived from ERP with others in the same department	1	2	3	4	5	6	7
I can share knowledge derived from ERP across departments	1	2	3	4	5	6	7
I can share my knowledge with others through the ERP network	1	2	3	4	5	6	7
Intention to Use (BIU)							
I intend to continue using ERP rather than discontinue its use	1	2	3	4	5	6	7
My intentions are to continue using ERP than use any alternative means (manual ways)	1	2	3	4	5	6	7
If I could, I would like to continue my use of ERP	1	2	3	4	5	6	7