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9 July 2011

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ISBN: [978-1-86435-644-1]; Full paper

Recommended Citation

Chang, Hsiu-Hua; Chou, Huey-Wen; Yin, Chun-Po; and Lin, Cecilia I., "ERP Post-Implementation Learning, ERP Usage And Individual Performance Impact" (2011). *PACIS 2011 Proceedings*. 35.
<http://aisel.aisnet.org/pacis2011/35>

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ERP POST-IMPLEMENTATION LEARNING, ERP USAGE AND INDIVIDUAL PERFORMANCE IMPACT

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Abstract

In recent years, an increasing number of companies that have implemented ERP systems have expressed disappointment over a failure to reach anticipated goals. A major reason for this failure is the inefficient use of the ERP system by employees. Therefore, the critical issue is how users can most effectively take advantage of an ERP system. Post-implementation learning plays an important role in facilitating ERP usage and thus promotes individual performance. Particularly, the integrated and sophisticated natures of ERP systems force users to learn continuously after ERP implementation. This study employed a survey method to examine the perceptions of a dataset of 659 ERP users. We found that ERP usage facilitates individual performance, including individual productivity, customer satisfaction and management control, and post-implementation learning contributes to all three types of ERP usage, including decision support, work integration and customer service. Our findings can provide academics and practitioners with knowledge of how to improve ERP usage and ensure individual performance impacts.

Keywords: Post-implementation learning, ERP usage, Individual performance impact.

1 INTRODUCTION

Many companies have adopted enterprise resource planning (ERP) systems for a variety of reasons, such as Y2K-related replacements, to cut costs, reengineer the business processes, compete globally, obtain competitive advantage and grow revenue (Loizos, 1998). Some companies using an ERP system have yet to reach their anticipated business goals (Bingi, Sharma & Godla, 1999) due to an under-utilization of ERP systems (Lorenzo, 2001; Ehie & Madsen, 2005; Jaspersen, Carter & Zmud, 2005). Venkatesh, Brown, Maruping and Bala (2008) indicate that an under-utilization of a new information system (IS) among employees undermines a company's efforts to gain benefits from such a system. An unwillingness among employees to use the newly-implemented ERP system is one of the most commonly cited reasons for ERP failures (e.g. Barker & Frolick, 2003; Scott & Vessey, 2002).

The consequences of ERP implementation depend on how the employees use the system in an organization (Pozzebon, 2000). Amoako-Gyampah and Salam (2004) suggest that even if ERP usage is mandatory, effective usage leads to organizational benefits. Information technology (IT), when used effectively, can result in great impacts on users' work. Therefore, how to stimulate users to use ERP systems effectively is a critical issue for organizations (Doll, Deng & Scazzero, 2003). The decision of adopting an ERP system depends on the company, while the usage and effort invested in learning the system rely on employees.

While training increases the ability to use an information system (IS) application (Compeau, Higgins & Huff, 1999), training programs are always provided before IS application implementation. Training prior to implementation is important, yet powerful and integrated IT applications force users to continue learning new skills. Doll et al. (2003) indicate that a lack of continuous IT learning will cause a gap between how IT is actually used and the realization of its full potential. Post-implementation learning is continuous learning after an IS system has gone live (Deng, 2000). Cooper and Zmud (1990) also suggest that post-implementation learning is the key to realizing IT's full potential. The more users continue to learn, the more effectively IT is used and the greater its impact on work (Doll, et al., 2003).

Lorenzo (2001) indicates that the ERP post-implementation stage is a new concern. As an ERP system is introduced into an organization, the effectiveness of the system becomes a crucial indicator of e-business success (Yu, 2005). On the practitioner's side, enhancing employee knowledge and skills to effectively use the ERP system is important. Therefore, after ERP implementation, to investigate the roles that post-implementation learning plays in ERP usage, enhancing individual performance impacts seem to be imperative. The purposes of this study are to recognize the role that post-implementation learning plays in facilitating ERP usage and examining the effect of ERP usage on individual performance.

2 CONCEPTUAL BACKGROUND AND HYPOTHESES DEVELOPMENT

This study proposes a research framework to investigate the role of post-implementation learning in the ERP post-implementation stage (Figure 1). First, we assume that ERP usage positively influences individual performance, including individual productivity, customer satisfaction and management control. Second, post-implementation learning positively affects ERP usage, including decision support, work integration and customer service.

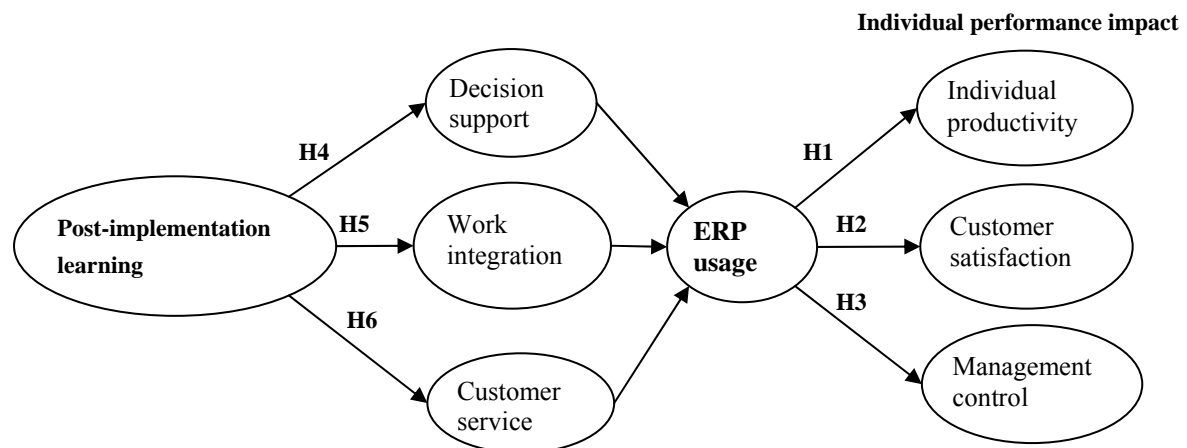


Figure 1. Research Framework

2.1 Individual Performance Impact

Academics and practitioners have recognized that IT success can be measured by its impact on an individual's work (Torkzadeh & Doll, 1999). Torkzadeh and Doll (1999) indicate that such an impact is a crucial concept that embodies downstream effects. IT impact on work at the individual level is a direct consequence of system use, which in turn is a major factor of determining organizational impact. Torkzadeh and Doll (1999: p. 328) claim that "it is difficult to imagine how information technology can be assessed without evaluating the impact it may have on the individual's work."

Hirschhorn and Farduhar (1985) indicate that IT impact on the nature of work depicts how IT is used in a post-implementation context, how it shapes the nature of work, and how it influences task performance at the individual level. Researchers have suggested four dimensions of impact—task productivity, task innovation, customer satisfaction and management control (e.g. Hirschhorn & Farduhar, 1985; Kraemer & Danziger, 1990). These dimensions describe how IT usage impacts individuals in an organizational context.

The individual performance impact of an ERP system refers to the actual performance of an individual using an ERP system. Gattiker and Goodhue (2005) indicate that the key benefits of ERP systems include higher quality data for decision making, efficiency gains in business processes and better coordination among different units or users. According to Zhang, Lee, Huang, Zhang and Huang (2005), ERP system success can be measured by four dimensions—user satisfaction, individual impact, organizational impact and intended business performance improvement. This study focuses on individual impact, which refers to improvements in an individual's productivity and task performance, and improvements in both the efficiency and quality of his or her decision making. Therefore, we assess the positive impact of an ERP system on individual performance by the following measures— individual productivity, customer satisfaction and management control.

2.2 ERP Usage

System usage has played a key role in IS literature and success models, as effective system usage is regarded as a major determinant of productivity (DeLone & McLean, 2003). Melone (1990) suggests that "performance-related" usage behaviors reflect how IT is actually used in an organization. Burton-Jones and Straub (2006) indicate that usage measurements should include three elements: (1) a user – the subject using the IS, (2) a task – the function being performed, and (3) a system – the object being used.

Doll and Torkzadeh (1998) indicate that IT is used by individuals in a work context to perform some relevant functions, including problem-solving/decision making, horizontal and vertical coordination of work activities, and customer service. This is a multidimensional concept of system usage and recognizes the organizational functions of IT in the post-implementation context. Lorenzo (2001: p. 1118) indicates that ERP systems “can be used for solving problems and justifying decisions (decision support), for coordinating activities among different business areas and among superiors and subordinates (work integration), and for servicing internal and external customer (customer service)”.

According to Doll and Torkzadeh’s system-to-value chain (1998), system usage is a major factor affecting work at the individual level. Individual performance is a direct result of usage (Doll & Torkzadeh, 1998; Torkzadeh & Doll, 1999). Cooper and Zmud (1990) also indicate that post-adoptive system usage enhances job performance. Kositanurit, Ngwenyama and Osei-Bryson (2006) suggest that usage significantly affects individual performance in an ERP environment. Lin, Hsu and Ting (2006) also find that ERP usage is positively related to individual impacts; that is, ERP usage would significantly impact an individual’s work in an organization. Hence, we propose the following hypotheses:

H1: ERP usage is positively associated with individual productivity.

H2: ERP usage is positively associated with customer satisfaction.

H3: ERP usage is positively associated with management control.

2.3 Post-implementation Learning

There exists a kind of knowledge that is informal in an organization, which generates an action (Tsoukas & Vladimirou, 2001); Collins (1990) names this “heuristic knowledge,” which he says arises from individuals engaging in their daily routines and improvising in response to confronting particular situations. Orr (1996) indicates that heuristic knowledge contributes significantly to efficient working.

Post-implementation learning refers to continuous learning after the implementation of an application (Deng, 2000). Learning has the potential to increase an individual’s capacity for effective action (Kim, 1993). Training provided before implementation enables users to gain operational skills, but the renowned complex nature of ERP systems limits the amount of knowledge that users can absorb before actual usage (Yi & Davis, 2003). Further, although ERP training before implementation may also increase users’ understanding of the software, this is not sufficient to ensure its sustainability (Clark, Jones & Zmud, 2006). The powerful and integrative applications emerging today require users to continuously learning new skills after IT implementation (Cook & Cook, 1994). Post-implementation learning emphasizes informal communication and knowledge sharing among users in informal activities. Feedback from other users can improve the usage of ERP systems (Nah & Delgado, 2006); that is, learning after actual usage will enhance users’ abilities and skills in using ERP systems further than the training provided before implementation.

Lorenzo (2001) indicates that ERP usage is influenced by training to users, and by knowledge transfer among users. Users are often helped by others to learn how to use the system effectively. In the context of ERP post-implementation, continuous learning and knowledge acquisition from others may facilitate effective ERP usage. Doll et al. (2003) indicate that post-implementation learning fosters continuous improvements in the effective use of IT, and the authors argue that a greater degree of continuous learning results in more effective IT usage. Further, post-implementation learning, which emphasizes learning in working and obtaining heuristic knowledge based in action, comes from communication and knowledge sharing among users. Communicating and sharing feedback offered by other users is likely to improve ERP usage (Nah & Delgado, 2006). Park, Suh and Yang (2007) suggest that knowledge transfer from social networks, such as peers and working groups, is a key factor for successful ERP usage. In this study, ERP usage includes decision support, work integration and customer service. We propose the following hypotheses:

H4: Post-implementation learning is positively associated with decision support.

H5: Post-implementation learning is positively associated with work integration.

H6: Post-implementation learning is positively associated with customer service.

3 RESEARCH METHODOLOGY

3.1 Data Collection

A cross-sectional mail survey was administrated to collect data among employees who use ERP systems in their daily work. We identified those companies that were willing to participate by way of telephone. Forty-seven companies were willing to answer the questionnaires. In each company we allocated a key person to deliver and collect the questionnaires.

3.2 Instrument Development

The measurement items used in this study are adapted from previous studies. Because an ERP system is a kind of IS or IT, we apply the measurements of IS usage and IT impact to ERP system and adjust it to fit the ERP system context. Multiple item measures are used for all variables, and all constructs are investigated by using a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The instrument used for the measurement of various research variables is described below.

An eleven-item scale is used to measure post-implementation learning adapted from Bock, Zmud, Kim and Lee (2005), van den Hooff and de Ridder (2004), Kwok and Gao (2005/2006), and Hoegl and Gemuenden (2001). ERP usage is conceptualized as a formative, second-order construct with three dimensions— decision support, customer service and work integration (Doll & Torkzadeh, 1998; Deng, Doll & Truong, 2004). Decision support includes problem-solving and decision rationalization. Work integration includes horizontal integration and vertical integration. Individual performance impact refers to an individual's perceived ERP performance impact on work, including individual productivity, customer satisfaction and management control, adapted from Torkzadeh and Doll (1999) and Park, et al. (2007).

4 DATA ANALYSIS

The proposed model conceptualizes the three first-order ERP usage dimensions and as formative indicators of the second-order ERP usage construct. We conduct measure validation and model testing using SmartPLS version 2.0. As PLS does not directly permit the representation of second-order latent constructs, we refer to Yi and Davis's (2003) research to test two submodels separately. Submodel 1 relates the first-order ERP usage constructs to their indicators and post-implementation learning, while submodel 2 relates the second-order ERP usage construct to the three dimensions of individual performance impact.

4.1 Descriptive Statistics

In total, 800 questionnaires were mailed, and 783 were returned, for a response rate of 98 percent. Because our target objects were the ERP system users, we withdrew the respondents of IT departments. We discarded the 124 questionnaires that were incomplete or inadequate. The final number of usable questionnaires was 659, for an actual response rate of 82 percent. Most of the respondents were aged 30 to 39 years. Approximately 71 percent of the respondents were females. The average tenure was about 4 years (shown as Table 1).

Statistics		Number	Percentage
Gender	Male	188	29%
	Female	471	71%
Age	20-29	226	34%
	30-39	352	53%
	40-49	72	11%
	Over 50	9	1%
Tenure	Less than 5 years	363	55%
	5-10 years	167	25%
	More than 10 years	129	20%

Table 1. Demographic Statistics (N=659)

4.2 Measurement Model

Construct reliability was measured using Cronbach's alpha and composite reliability (CR). Cronbach's alphas of all constructs range from 0.849 to 0.947, and CRs range from 0.908 to 0.958. All scores were over the cutoff of 0.7 (Nunnally, 1978; Straub, 1989). Convergent validity is assessed using two criteria—(1) each item should have a statistically significant factor loading on its specified construct significant and should exceed 0.7 (Fornell & Larcker, 1981; Agarwal & Karahanna, 2000), and (2) averaged variance extracted (AVE) for each construct should exceed 0.5 (Fornell & Larcker, 1981). The factor loadings of all items are larger than 0.8 and highly significant. Moreover, the AVEs range between 0.704 and 0.883, and hence all exceed the recommended level of 0.5 (shown in Tables 2 and 3). These results support the presence of convergent validity. Discriminant validity is measured using the square root of the AVE by a construct from its indicators, which should exceed that construct's correlation with other constructs (Chin, 1998; Fornell & Larcker, 1981). The diagonal elements presented the square root of AVE are larger than off-diagonal elements in the same row and column (shown in Tables 2 and 3), suggesting good discriminant validity.

Chin (1998) indicates that these criteria for reliability and validity are inappropriate for latent construct with formative indicators, such as ERP usage. We conduct two procedures to measure the construct validity of ERP usage—(1) to examine the weights of the formative indicators to drop non-significant indicators (Diamantopoulos et al., 2001), and (2) to measure the multicollinearity of formative indicators using VIF statistics. Because formative indicators are supported to cover different aspects of the construct, they should have low multicollinearity. Diamantopoulos, et al. (2000) suggest that VIF statistics should be lower than 3.3 to demonstrate well construct validity. Table 4 presents that all indicator-construct weights are significant. Furthermore, VIF statistics are smaller than 3.3, showing that these indicators are different from each other and measure different aspects of ERP usage.

4.3 Structural Model

We assess the structural model and hypotheses by examining path coefficients and their significance levels. The results are shown in Figure 2. All proposed paths are significant. The coefficients on the path from post-implementation learning to three dimensions of ERP usage are supported, as decision support is 0.536 ($t = 5.95, p < 0.001$), work integration is 0.404 ($t = 4.23, p < 0.001$) and customer service is 0.419 ($t = 4.12, p < 0.001$). Thus, these positive relationships support Hypothesis 4, Hypothesis 5 and Hypothesis 6. The path coefficients from ERP usage to three dimensions of individual performance impact are supported, as individual productivity is 0.598 ($t = 7.24, p < 0.001$), customer satisfaction is 0.710 ($t = 10.53, p < 0.001$) and management control is 0.668 ($t = 8.67, p < 0.001$). Hypothesis 1, Hypothesis 2 and Hypothesis 3 are supported.

The structural model shows that post-implementation learning explains 28.7 percent of the variance in decision support, 16.3 percent of the variance in work integration and 17.5 percent of the variance in

customer service. ERP usage explains 35.8 percent of the variance in individual productivity, 49.1 percent of the variance in customer satisfaction and 44.6 percent of the variance in management control.

Construct	1	2	3	4
1. Post-implementation learning	0.839			
2. Decision support	0.536**	0.876		
3. Work integration	0.404**	0.645**	0.868	
4. Customer service	0.419**	0.666**	0.760**	0.933
Mean	5.226	4.837	4.399	4.603
S.D.	0.771	0.952	0.961	1.035
Cronbach's Alpha	0.947	0.849	0.919	0.926
CR	0.955	0.908	0.939	0.953
AVE	0.704	0.768	0.754	0.872

Table 2. Reliability, Correlation Coefficients and AVE Results – Submodel 1
*Note: The main diagonal shows the square root of the AVE; ** $p < 0.01$*

Construct	1	2	3	4
1. ERP usage	0.891			
2. Individual productivity	0.598**	0.859		
3. Customer satisfaction	0.701**	0.748**	0.924	
4. Management control	0.668**	0.765**	0.806**	0.936
Mean	NA	4.903	4.771	4.863
S.D.	NA	1.001	0.961	0.992
Cronbach's Alpha	NA	0.934	0.914	0.861
CR	NA	0.958	0.946	0.935
AVE	0.794	0.883	0.853	0.877

Table 3. Reliability, Correlation Coefficients and AVE Results –Submodel 2
*Note: The main diagonal shows the square root of the AVE; ** $p < 0.01$*

Construct	Weight (from PLS)	<i>t</i> value	Sig.	Collinearity statistics	
				Tolerance	VIF
Decision support	0.386	68.97	.000	0.507	1.971
Work integration	0.359	82.63	.000	0.386	2.587
Customer service	0.378	100.90	.000	0.368	2.716

Table 4. Construct Validities of ERP usage

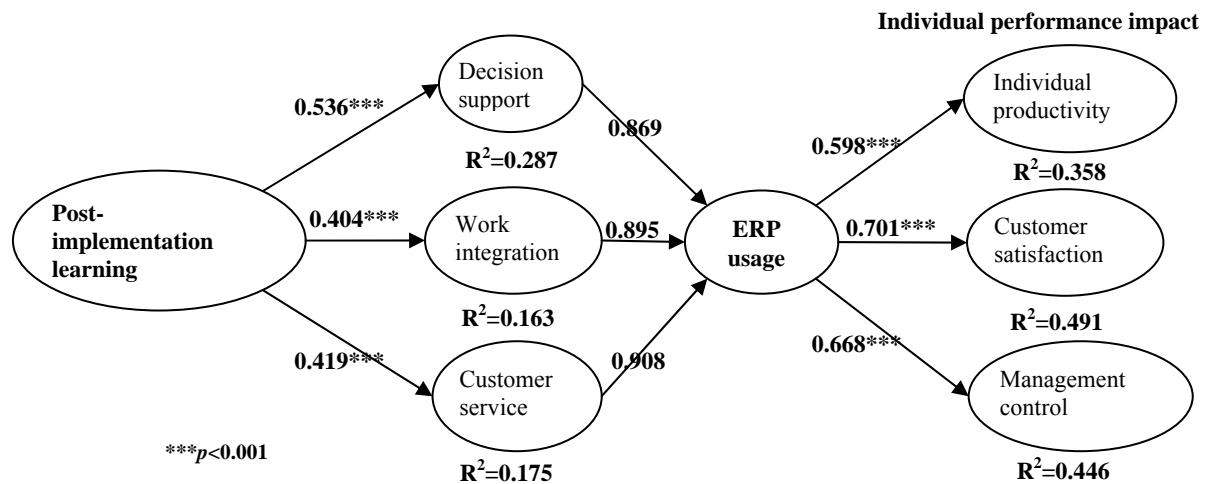


Figure 2. PLS Test Result of Proposed Model

5 DISCUSSION

The findings and interpretations based on the empirical analysis are discussed below.

First, post-implementation learning is found to have significant effects on ERP usage, including decision support, work integration and customer service.

As shown by the significant and positive paths in Figure 2, post-implementation learning is found to play an important role in three dimensions of ERP usage—decision support, work integration and customer service. Users who continue to learn are likely to foster ERP usage. This is consistent with previous studies (Doll, et al., 2003; Nah & Delgado, 2006). This may be because ERP systems result in business process reengineering and change the way of work. The knowledge gained from pre-implementation training that users are able to absorb is limited. Post-implementation learning emphasizes knowledge sharing and communication among users to obtain heuristic knowledge. This allows users to effectively use the software. When one person discovers how to perform a particularly useful task, colleagues can then quickly update their skills (Boudreau, 2003). Therefore, post-implementation learning may facilitate ERP usage. Among the three dimensions of ERP usage, the effect of post-implementation learning on decision support ($\beta = 0.536$, $p < 0.001$) is higher than both work integration ($\beta = 0.404$, $p < 0.001$) and customer service ($\beta = 0.419$, $p < 0.001$). This indicates that post-implementation learning is more helpful for supporting decision making.

Second, ERP usage is found to have significant effects on individual performance impact, including individual productivity, customer satisfaction and management control.

As hypothesized above, the system usage of employees is likely to achieve greater individual performance impact. The results of this study, which are consistent with Kositanurit et al. (2006), show a significant and positive linkage between ERP usage and three dimensions of individual performance impact—individual productivity, customer satisfaction and management control. This is because the informing role of ERP systems, which be defined as the use of ERP systems to generate information about processes through that an organization conducts its work. For example, ERP systems streamline interdepartmental processes and reduce the burden of administrative minutiae, and then increase individual productivity. Besides, by linking the ordering and production systems, a sales representative is able to promise firm delivery dates, which then translates into improved service levels. Thus, employees using the ERP system could facilitate customer satisfaction. That is, ERP systems can provide differentiated and customized service to internal and external customers, solve problems and justify decisions, and coordinate activities among different business areas (Lorenzo, 2001). Employees can complete their work efficiently, provide customers satisfactory service and

regulate their work processes and performance through the use of ERP systems. Among the three dimensions of individual performance impact, the effect of ERP usage on customer satisfaction ($\beta=0.701$, $p < 0.001$) is highest, followed by management control ($\beta=0.668$, $p < 0.001$). This indicates that the usage of ERP systems may result in greater customer satisfaction.

6 CONCLUSION

ERP systems play an increasingly important role in organizational operations. Many organizations have already made huge investments in ERP systems; therefore, many organizations are concerned over whether they have gained benefits from adopting ERP systems. Prior research has indicated that effective ERP usage results in notable benefits (Doll & Torkzadeh, 1998; Lorenzo, 2001). How to facilitate users' effective ERP usage is crucial. Kim (1993) indicates that learning can increase the capability for effective action. Although employees can learn ERP systems through training programs, most of these programs were provided before ERP implementation. The integrated and complex characteristics of ERP systems limit the amount that users can absorb before actual usage (Yi & Davis, 2003) and force users to continue to learn after implementation.

This study focuses on the ERP post-implementation stage to reveal the role of post-implementation learning in fostering ERP usage, then demonstrating the resulting individual performance impact. By means of empirically assessing our proposed model, this study highlights the value of post-implementation learning in facilitating ERP usage, including work integration, customer service, especially decision support. ERP usage then enhances individual performance impact, including individual productivity, management control and, most significantly, customer satisfaction. The findings are consistent with previous studies (Doll, et al., 2003; Kositanurit et al., 2006; Nah & Delgado, 2006).

There are limitations of this study that should be mentioned. (1) Self-reported data were used to assess ERP usage and individual performance impact. This single-source method may result in common method bias. Future research should employ multiple assessments, such as collecting data from managers or using secondary data to avoid this problem. (2) The unit of analysis is at the individual level. In an organization, individual behaviors are likely to be influenced by contextual factors, such as organizational climate and culture. Future studies should include these factors to make the research more comprehensive.

There are several theoretical implications of these findings. (1) This study highlights the value of post-implementation learning in facilitating ERP usage, including decision support, work integration and customer service, after ERP system implementation. Past research has indicated that an individual's personality and cognitive style have critical effects on learning (Jonassen & Grabowski, 1993). Future research could take these into account and investigate the effects of individual differences on post-implementation learning in the ERP post-implementation phase. (2) This study presents empirical evidence that ERP usage significantly affects individual performance impacts, including individual productivity, customer satisfaction and management control, after ERP implementation. Prior researchers have proposed a variety of usage concepts, including routine or habitual use, extended use and emergent use (Saga & Zmud, 1994; Jasperson, et al., 2005). Future research may operationalize ERP usage with these concepts to explore the effects on individual performance and the role of post-implementation learning.

This study provides evidence that post-implementation learning is an important factor in ERP usage. The empirical results of this study can provide companies with knowledge of how to improve ERP usage and individual performance impacts. The research results confirm that post-implementation learning significantly fosters ERP usage and proves that employees prefer asking colleagues for help, as indicated by Boudreau (2003). ERP usage can be improved by knowledge sharing and communication among employees (Nah & Delgado, 2006). Managers should establish effective policies and design activities to encourage knowledge exchange among employees after ERP implementation. Moreover, organizations should hold meetings and workshops, or create communication channels to encourage users to interact with colleagues. Accordingly, employees

could increase their skills and knowledge to effectively use ERP systems in their daily work, thus promoting their performance. With this, organizations are most likely to reach the anticipated benefits from ERP systems.

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