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Wen-Hsien Tsai  
*National Central University*

Shih-Wen Chien  
*National Central University*

Yi-Wen Fan  
*National Central University*

Julian Cheng  
*National Central University*

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# A Survey of ERP System Implementation in Taiwan

Wen-Hsien Tsai

Dept. of Business Administration  
National Central University  
Chung-Li, Taiwan 320  
whtsai@mgt.ncu.edu.tw

Shih-Wen Chien

Dept. of Business Administration  
National Central University  
and Dept. of Finance  
Ching Yun University  
Chung-Li, Taiwan 320  
shihwen@mail.cyu.edu.tw

Yi-Wen Fan

Dept. of Information Management  
National Central University  
Chung-Li, Taiwan 320  
iwfan@mgt.ncu.edu.tw

Julian M.-S. Cheng

Dept. of Business Administration  
National Central University  
Chung-Li, Taiwan 320  
jcheng@mgt.ncu.edu.tw

## Abstract

*This paper presents the results of a recently completed survey of Taiwanese firms that focuses on their implementation and use of packaged ERP systems. Objectives of the survey includes: to investigate the extent to which packaged ERP systems were applied in manufacturing and service firms, the implementation experience, and the major benefits obtained from the implementation. Findings of the survey indicate that the firms implemented with all planned modules tend to have more successful implementation, and use of ERP systems from evolution of the legacy systems, in-house redevelopment and outsourcings are critical to organizational performance and survival. Furthermore, our research results findings suggest that both researchers and companies should adopt broader definitions and multiple performance measures indexes of success and pay particular attention to the early identification and correction of problems.*

**Keywords:** ERP (enterprise resource planning), ERP experience cycle, Balanced Scorecard, Performance measures indexes

## 1. Introduction

In recent years, organizations face mounting competition, growing markets, and increasingly selective customers. They seek the means to achieve better business performance and competitive advantage through effective employment and management of their resources and business process. To improve business performance, organizations need an efficient planning and control system to enable synchronized planning across all processes of the organization. The key to competitiveness is a strong information system (IS) infrastructure aligned with core business processes aimed at the delivery of high quality products and services to customers in the shortest possible time. These demands have led more and more firms shift their information technology (IT) strategies from developing in-house information systems to buying application software, such as Enterprise Resource Planning (ERP) systems, so as to generate synergies and enhance operating efficiency (Hong and Kim, 2002). ERP systems can shorten cycle time, speed up information dissemination, improve financial management, lay the groundwork for e-commerce, and render tacit knowledge explicit provided they are properly implemented in a business organization (Davenport, 2000). Additionally, ERP systems can reshape business structures because they can solve the challenges created by portfolios of supposedly disconnected and uncoordinated business applications (Davenport, 1998).

However, ERP system implementation can be both expensive and time-consuming (Abdinnour-Helm et al., 2003; Kumar et al., 2003). Due to the constraints of budget and time, some companies may employ a phased implementation approach, that is, modules are implemented one at a time or a group of modules implemented often in a single location at a time. Phased implementation requires substantial attention and maintenance given to legacy

systems in order to facilitate integration with the new ERP system. Moreover, there may not be enough modules implemented to achieve functionality. However, the so-called “big-bang” approach, where an entire suite of ERP modules is implemented at all locations at the same time, has both advantages and disadvantages too (Mabert et al., 2003). In accordance with multiple perspectives in implementation method, this investigation endeavors to examine crucial management issues in ERP implementation by focusing on the organizations that have successfully implemented ERP systems.

## 2. Methodology

Understanding issues about ERP experience cycle can help direct ERP research agenda. Sustained interest in implementing and realizing the benefits of ERP systems and the consequent lifecycle issues provides the rationale for this study, which deals with specific issues related to ERP experience cycle implementation, management and support in the context of the Taiwanese firms.

The importance of considering ERP success at multiple points in time was made clear in a case study by Larsen and Myers (1997) in which a successfully installed ERP system was later terminated when the company merged with another. This investigation examines key critical management issues during the “ERP experience cycle” (Markus et al., 2000). ERP implementation involves four distinct phases, namely: (1) *the chartering phase comprising decisions leading up to the funding of an ERP system. The key activities during this phase include establishing a business case for ERP systems, selecting a software package, identifying a project manager, and approving a budget and schedule;* (2) *the project phase, during which ERP is configured and rolled out to the organization;* (3) *the shakedown phase, during which the company makes the transition from “go-live” to “normal operations”;* and (4) *the onward and upward phase, during which the company achieves most of its business benefits.* These phases can be divided into three stages: ERP pre-implementation (the chartering phase), implementation (the project phase) and post-implementation (the shakedown and onward-upward phases).

### 2.1 Data Collection

A questionnaire survey regarding the implementation of ERP systems in Taiwan was conducted in 2003. The questionnaire focused on five areas: the characteristics of ERP implementation, ERP implementation status, evaluation of the pre-implementation process, implementation experience and ERP system configuration, as well as benefits of ERP system and future directions.

Table 1 Current use of the ERP package

ERP status (N=657)*	Freq.	Valid %
All planned modules being successfully implemented	146	22.2
Only parts of the planned modules being successfully implemented	137	20.9
Still in the implementation stage	93	14.2
Under evaluation	136	20.7
Being evaluated, and determined not to implement temporarily	50	7.6
Without any consideration so far	95	14.4

\*N=657: total response sample

The questionnaire asked respondents for basic enterprise data about current use of the ERP package (Table 1). In this survey, 3,597 questionnaires were forwarded to companies in manufacturing and services industries that rank as the top 5,000 in Taiwan in 2001. The questionnaire was developed from ERP experience cycle and used as a tool for determining management issues influencing top managers, project managers, key users and end users. Of the 3,597 questionnaires mailed, 657 (18.27% of 3597) usable responses were returned, among which 93 (14.16% of 657) were still in the implementation stage, 137 (20.85% of 657)

implemented parts of the planned modules, and 146 (22.22% of 657) implemented all planned modules. These results indicate that almost 57.3% of firms are pursuing ERP implementation, and this research chooses to concentrate on the 283 respondents (43.1% of 657) who have successfully implemented ERP systems to examine how the survey findings implicate critical management issue.

## 2.2 Data Analysis

### 2.2.1 Descriptive Statistics of the Successful Implemented ERP Systems

According to Table 1, 283 companies (43.1% of 657) have successfully implemented ERP systems, and relevant statistic data of the sample suggest that the 283 respondents incorporate 22 foreign companies, 20 domestic-foreign joint ventures and 241 domestic companies in Taiwan (Table 2). The sample contains 238 (84.1% of 283) companies with fewer than 300 employees and 224 companies (79.1% of 283) with annual revenues below NT\$5 billion. Among these organizations, approximately 201 companies (71% of 283) are manufacturers and 82 companies (29% of 283) are service industries.

Table 2 Descriptive statistics of the successful implemented ERP

Employee numbers (N=283)*	Freq.	Valid %	Company ownership (N=283)	Freq.	Valid %
<100	53	18.7	Foreign	22	7.8
100 to 300	185	65.4	Domestic-foreign joint venture	20	7.1
301 to 600	5	1.8	Domestic	241	85.2
>600	40	14.1			
Industry (N=283)			Company age (N=283)		
Food	6	2.1	< 10 years	56	20.8
Cotton & Rag trade	12	4.2	10 to 20 years	81	30.1
Plastics & rubber	10	3.5	21 to 30 years	64	23.8
Chemical manufacturing	10	3.5	>30years	68	25.3
Electronic & Generator	56	19.8	Missing data	14	
Information product	31	11.0	Annual revenue (NT\$ billion) (N=283)		
Enginery/iron/steel	27	9.5	<0.5	34	12.0
Conveyance	20	7.1	0.5 to 1	71	25.1
Other manufacturing	29	10.2	1.1 to 5	119	42.0
Common carrier	8	2.8	>5	59	20.8
Sales	10	3.5	Industry sector (N=283)		
Trade	11	3.9	Manufacturing	201	71.0
Financial/insurance	10	3.5	Services	82	29.0
Building/real estate	8	2.8			
Other services	35	12.4			

\*N=283: 146 firms of all planned modules being successfully implemented and 137 firms of only parts of the planned modules being successfully implemented

Breakdown of the sample by industry identifies electronic and generator (19.8%) and information product (11.0%) as the top two leading industries, suggesting that hi-tech companies tend to be more experienced in ERP implementation than their counterparts in other industries. This further implies that application packages such as ERP system offer one solution to chronic custom system design problems in the high technology industry. From Table 2 that summarizes the descriptive statistics of companies with successfully implemented ERP systems, we find the interesting fact that a great majority of the respondents are small-medium enterprises with an annual revenue below NT\$5 billion and a total number of employees less than 300.

### 2.2.2 ERP System Sources and Integration with Other IT Systems

Concern for lack of feature-function fit prompts many companies to pay close attention

to find the right ERP system compatible with the company's requirements. Nevertheless, most of the ERP software available in the marketplace are packaged systems which are primarily proprietary systems rather than open system architectures. Packaged ERP systems often offer numerous options representing best practices (Teltumbde, 2000). The built-in features of packaged ERP systems, however, also limit the flexibility of the selected enterprise software (Umble et al., 2003). For example, SAP R/3 requires the adopting firms to adapt their business processes to the business procedure embedded in the SAP R/3 system. Furthermore, companies with the required expertise can design their own systems for integration with other systems. Some companies in Taiwan employ non-packaged ERP systems that stem from evolution of legacy systems, in-house development software, or outsourcing. ERP vendors design their packaged ERP systems to be the universal package software for various industries and organizations. Even so, it is impossible for any organization to install a packaged ERP system without any tailoring or add-on. Thus, it is not advantageous to adopt an ERP system if it requires considerable modifications.

As our research on Taiwan firms indicates, about 9% of in-house redevelopment software, 14.3% of outsourcing and 14.7% of evolution from legacy systems is sufficiently flexible to creatively solve integration problems (Table 3). On the other hand, it seems that most firms prefer a single ERP package as 42.7% of the respondents expect a single ERP system to provide complete functionality for all business needs. Less than 20% of the firms options for a multi-faceted approach that employs a mixture of ERP systems with other systems.

Of the 283 firms with successfully implemented ERP systems, 132 (46.6% of 283) have not integrated ERP systems with other systems. This result deserves our attention because it sheds light on the firms' interest in utilizing a packaged ERP system to run the business. On the one hand, approximately 46.6% of the firms have yet to reach the onward and upward phase that continues from normal operation until the system is replaced with an upgrade or different version. On the other hand, several firms are found to have achieved the full potential benefits of ERP system; they view implementing a packaged ERP system as the start of a long journey, with various future enhancements anticipated. For example, 26.5% of the firms have implemented or are implementing Supply Chain Management (SCM) to be integrated with ERP systems. And 24% of the firms have integrated ERP systems with Customer Relationship Management (CRM) system.

Table 3 ERP system sources and integration with other IT systems

ERP system sources (N=283)*	Freq.	Valid %
Evolution from legacy systems	41	14.7
In-house redevelopment	25	9.0
Outsourcing	40	14.3
Single ERP package	119	42.7
A mixture of an ERP packages with other systems	54	19.3
Missing data	4	
Integration of ERP with other IT systems (N=283)		
No integration	132	46.6
SCM	75	26.5
CRM	68	24.0
APS	49	17.3
Knowledge management (KM)	35	12.4
Others	25	8.8

\*N=283: 146 firms of all planned modules being successfully implemented, and 137 firms of only parts of the planned modules being successfully implemented.

### 2.2.3 Implementation Costs, ERP System Status and ERP System Sources – Independent Sample Test

Installing a full-fledged ERP system costs less than NT\$5 million for 33% of the adopting companies (Table 4). Approximately 230 firms (86.1%) spend a total project cost below NT\$50 million including the hardware and consulting services for implementing ERP systems. This evidence shows that the cost of the packaged ERP system implementation varies significantly among enterprises in different sizes. Our findings further show that around 84.4% of the adopting companies invest less than 10% of their annual revenues on IT expenses, and approximately 76.4% of the companies maintain an ERP staff whose size is less than 10% of the total employee number.

Of the 283 companies that have implemented ERP systems, 146 (51.59% of 283) have implemented all the planned modules and 137 (48.41% of 283) have implemented partial planned modules. From Table 5, we can see obviously that the ERP system status and total ERP system cost are significantly different between these two groups ( $p < 0.05$ ). That is, the companies having successfully implemented all the planned modules register a higher ERP system cost than those having successfully implemented only partial planned modules. It is then a reasonable guess that a company will need to invest more money if the implementation of all the planned modules is desired.

Table 4 Implementation costs

Total ERP system cost (NT\$ million) (N=283)*	Freq.	Valid %
< NT\$5 million	88	33.0
NT\$5 million to NT\$10 million	65	24.3
NT\$11 million to NT\$50 million	77	28.8
NT\$51 million to NT\$100 million	16	6.0
> NT\$100 million	21	7.9
Missing data	16	
<b>Average annual IT expense / Annual revenue (N=283)</b>		
< 10%	232	84.4
10% to 20%	30	10.9
21% to 30%	9	3.3
> 30%	4	1.5
Missing data	8	
<b>Number of ERP Staff/ Total employee number (N=283)</b>		
< 10%	214	76.4
10% to 20%	22	7.9
21% to 30%	16	5.7
31% to 40%	11	3.9
> 40%	17	6.1
Missing data	3	

\*N=283: 146 firms of all planned modules being successfully implemented, and 137 firms of only parts of the planned modules being successfully implemented.

Table 5 ERP status, implementation cost and Independent Samples Test

	ERP status (N=283)	N	Mean	Std. Deviation	t-test for Equality of Means			
					t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Total ERP system cost	1	136	2.52	1.26	2.886	0.004**	0.42	0.15
	2	131	2.10	1.13				
Average annual IT expense / Annual revenue	1	140	1.24	0.58	0.519	0.604	0.04	0.07
	2	135	1.20	0.56				
Employee number about ERP system / Total employee number	1	144	1.56	1.16	0.133	0.894	0.02	0.14
	2	136	1.54	1.15				

\*( $p < 0.10$ ), \*\*( $p < 0.05$ ), \*\*\*( $p < 0.01$ )

ERP status: 1= 146 firms of all planned modules being successfully implemented

2= 137 firms of only parts of the planned modules being successfully implemented

In Table 6, we further find significant differences between these two groups ( $p < 0.1$ ) in terms of ERP system sources and total ERP system cost. Moreover, the number of ERP staff to total employee number is also significantly different between these two groups ( $p < 0.05$ ). This is an interesting evidence suggesting that the firms adopting packaged ERP systems sustain a cheaper cost than those who find their sources in evolution from legacy system, in-house redevelopment, and outsourcing. However, users of packaged ERP systems need to have a greater number of employees to facilitate the implementation and may have to train users employees to learn and operate the package ERP systems.

Table 6 ERP system sources, implementation cost and Independent Samples Test

	ERP system sources (N=283)	N	Mean	Std. Deviation	t-test for Equality of Means			
					t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Total ERP system cost	1	100	2.50	1.26	1.933	0.054*	0.30	0.15
	2	163	2.20	1.18				
Average annual IT expense / Annual revenue	1	105	1.25	0.58	0.685	0.494	0.05	0.07
	2	166	1.20	0.56				
Employee number about ERP system / Total employee number	1	105	1.36	0.96	-2.283	0.023**	-0.30	0.13
	2	171	1.67	1.24				

\*( $p < 0.10$ ), \*\*( $p < 0.05$ ), \*\*\*( $p < 0.01$ )

ERP system sources: 1= 41 firms of evolution from legacy systems, 25 firms of in-house redevelopment, and 40 firms of outsourcing.

2= 119 firms of single ERP package, and 54 firms of a mixture of an ERP packages with other systems.

### 3. Findings and Management Implications - Implemented packages ERP system

#### 3.1 Packaged ERP Systems and ERP Modules

The Ding Hsin (Taiwan) ERP software rounds up 33.1% of the market of single-package ERP systems in Taiwan, with Oracle ranking a distant second with an approximately 15.7% market share. The “Other ERP packages” category reports a fairly substantial 14.5%. The results illustrate the dominance of local sources in Taiwan’s market of packaged ERP systems.

Although packaged ERP systems are designed using numerous modules to provide a broad range of functional supports, firms may select some modules to implement. The results show that over 68% of the adopting companies in Taiwan have installed the following six modules: Financial Accounting (93.6%), Purchasing Management (91.9%), Material Management (82.1%), Sales Distribution (79.2%), Fixed Asset Management (69.4%), and Production Planning (68.2%) (Table 7).

Table 7 Implemented ERP software packages and ERP modules

Implemented ERP package (N=173)*	Freq.	Valid %	Implemented ERP modules (N=173)	Freq.	Valid %
SAP	14	8.1	Financial Accounting	162	93.6
Oracle	27	15.7	Purchasing Management	159	91.9
J.D. Edwards	5	2.9	Material Management	142	82.1
Baan	3	1.7	Sales Distribution	137	79.2
QAD	4	2.3	Fixed Asset Management	120	69.4
Platinum	1	0.6	Production Planning	118	68.2
Ding Hsin (Taiwan)	57	33.1	Human Resource	69	39.9
Proyoung (Taiwan)	8	4.7	Management Accounting	60	34.7
Fast Tech. (Taiwan)	9	5.2	Quality Management	52	30.1
IE (Taiwan)	16	9.3	R&D	33	19.1
Teammax (Taiwan)	1	0.6	Financial Management	20	11.6
Other ERP packages	25	14.5	Investment Management	9	5.2
Multiple ERP packages	2	1.2	Others	9	5.2
Missing data	1				

\*N=173: 119 firms using single ERP package and 54 firms using a mixture of an ERP package with other systems.

### 3.2 ERP Pre-implementation

Table 8 summarizes the answers of respondents to questions regarding the internal drivers and external partners for packaged ERP system implementation. The results show that “CEO is the main internal driver” (45.1%) and “ERP vendors are the most important implementation partners” (82.7%). Most of the adopting companies partner with either ERP vendors or consultants from consulting firms during the process of their ERP implementation. A few organizations prefer to work with individual consultants (3.5%). Our research results further identify ERP vendors as the key implementation partners teaming up with the organizations to facilitate system adoption, implementation and stabilization.

Table 8 Main internal drivers and implementation partners

Main internal drivers (N=173) *	Freq.	Valid %	Implementation partners (N=173)	Freq.	Valid %
Board chairmen	24	13.9	Consultants from ERP vendors	143	82.7
CEO	78	45.1	Consultants from consulting firms	20	11.6
CIO	43	24.9	Individual consultants	6	3.5
Others	14	8.1	Others	4	2.3
Missing data	14				

\*N=173: 119 firms using single ERP package and 54 firms using a mixture of an ERP package with other systems.

### 3.3 ERP Implementation

IS development projects are considered to have concluded successfully when they are completed on time, within budget, with the desired functionality, and in high quality (DeLone and McLean, 1992). The results of our survey report a fairly time consuming implementation, with most firms spending over six months (Table 9). A close correlation has also been detected between the implementation time and the implementation strategy, which can range from module phasing to a single go-live date for all modules (big-bang). However, Mabert et al. (2000) noted that U.S. firms employing a big-bang approach experience the shortest implementation time while phased implementation increases the time required to go live. In the US scenario, firms that employ rapid implementation enjoy the shortest implementation time while phased implementation is associated with longer implementation. Our survey, however, finds that implementation strategies differ between Taiwanese and U.S. firms. The issue of ERP implementation strategy should therefore be reviewed in more detail so as to determine the impact of ERP system implementation on the enterprise.

Table 9 Implementation duration/strategies/responsibility

Implementation Duration (N=173) *	Freq.	Valid %
< 6 months	41	25.0
6 to 12 months	72	43.9
13 to 24 months	40	24.4
> 24 months	11	6.7
Missing data	9	
Implementation Strategies (N=173)		
Integral planning and Big-bang implementation approach	69	40.1
Integral planning and phased implementation approach	75	43.6
Stepwise planning and phased implementation approach	28	16.3
Missing data	1	
Implementation responsibility (N=173)		
Information departments	83	49.1
Project teams	84	49.7
Others	2	1.2
Missing data	4	

\*N=173: 119 firms using single ERP package and 54 firms using a mixture of an ERP package with other systems.



Package ERP system implementation can be complex and difficult, but a structured and disciplined approach can significantly facilitate the implementation (Umble et al., 2003). This is why project teams (49.7%) are organized to take charge of ERP implementation; the best business practice is for the project team to manage every aspect of the implementation, including schedule and plans, monitoring and feedback, and risk management.

Projects that do not meet one or more of these criteria are, naturally, considered less successful (Ford and McLaughlin, 1992). The top three reasons for IT-related project failure, as surveyed by *Information Week*, include poor planning or poor management (cited 77%), changes in business goals during the project (75%), and lack of business management support (73%) (Stein, 1999). The major ERP implementation problems, however, emerge from our study in the following order: (1) failure to describe the requirements for the ERP system by departments (46.8%); (2) The ERP system failing to meet the firm's requirements, and other add-on programs being necessary (38.7%); (3) delay of the project implementation schedule (37.0%); (4) lack of ERP system to fit corporate process (35.3%) (Table 10). More often than not, the organization may adopt only certain parts of the packaged ERP system or modify the system to improve feature-function fit.

Table 10 ERP implementation problems

ERP implementation problems (N=173)*	Freq.	Valid %
Failure to describe the requirement for the ERP system by departments	81	46.8
The ERP system failing to meet the firm's requirements, and other add-on programs being necessary	67	38.7
Delay of the project implementation schedule	64	37.0
Lack of ERP system to fit corporate processes	61	35.3
Inadequate IT members	54	31.2
Employee resistance	53	30.6
No enough understanding on the ERP functions by organization members	52	30.1
Lack of participation by user units	51	29.5
Lack of understanding of consultants on corporate operational processes	51	29.5
Lack of IT knowledge of organization members	51	29.5
Not well prepared of organization members to use the ERP system as tools for assisting their work	50	28.9
Lack of participation by top management	48	27.7
Lack of modification of firms' current policies and processes to fit the ERP system	47	27.2

\*N=173: 119 firms using single ERP package and 54 firms using a mixture of an ERP package with other systems.

### 3.4 ERP Post-implementation

#### 3.4.1 ERP Post-Implementation Problems

While several companies have achieved considerable efficiencies through ERP systems, others have complained of implementation failure, budget overruns, and disappointing performance (Bradford and Florin, 2003; O'Leary, 2000). Although employees have been trained to learn how ERP systems work and relate to the company's business process early in the implementation process, "insufficient education and training courses for employees" (57.2%) is still cited in our survey as the major problem during the post-implementation phase. Consequently, we propose that employees should receive sufficient training course, even during the post-implementation stage, to enable them to use the new system effectively. Periodic meetings/trainings of system users can help identify system problems and encourage the exchange of information gained from experience and increasing familiarity with the system (Krupp, 1998). Performance measures that assess the influence of the new system must be carefully constructed (Umble et al., 2003). Naturally, such performance measures should indicate system performance. This survey observes periodic performance measurement to be lacking in ERP post-implementation stage for 71 (41.0%) of the 173 companies having successfully implemented all or parts of the planned modules (Table 11).

Table 11 ERP post-implementation problems

ERP post-implementation problems (N=173)*	Freq.	Valid %
Insufficient education and training courses for employees	99	57.2
Lack of performance evaluation periodically	71	41.0
System operational difficulty by users	62	35.8
Insufficient supports and services from vendors	61	35.3
Delay of the project implementation schedule	47	27.2
Insufficient supports and services from consultants	43	24.9

\*N=173: 119 firms using single ERP package and 54 firms using a mixture of an ERP package with other systems

### 3.4.2 Implementation Strategies and Performance Improvement

In this paper, we utilize DeLone and McLean (1992) IS success model to develop ERP performance measures. DeLone and McLean (1992) divided IS success measure into six dimensions as follows: (1) System Quality: measures of the information processing system itself. (2) Information Quality: measures of the information system output. (3) System Use: measures of recipient use of information system. (4) User Satisfaction: measures of recipient response to the use of information system. (5) Individual Impact: measures of the effect of information on the behavior of the recipient. (6) Organizational Impact: measures of the effect of information on organizational performance.

According to the average importance score rankings obtained in a pilot study, the top five important performance measures were selected for each success dimension of DeLone and McLean's model (1992), except for the *Organizational Impact* dimension, for which 12 measures were selected. Regarding the assessment of *Organizational impact*, the questionnaire lists 12 measures divided into four categories based on the *Balanced Scorecard* concept of Kaplan and Norton (1992). The questionnaire asks respondents to evaluate the level of performance improvement by each of the 37 selected ERP performance measures with 7-point Likert-type scales ranging respectively from 1 (substantial deterioration) to 7 (substantial improvement). The data obtained are used to determine the level of improvement of *System Quality*, *Information Quality*, *System Use*, *User Satisfaction*, *Individual Impact*, and *Organizational Impact* by averaging the various indexes' scores for each case under each dimension in the ERP post-implementation stage. The top five performance improvement levels following ERP system implementation occur in: (1) data transmission time between departments (6.05), (2) data currency (5.97), (3) database contents (5.94), (4) data accuracy (5.90), (5) timeliness of information provision (5.88) (Table 12).

We use Scheffe Test for implementation strategies and performance improvement and find that, except the level of improvement of *System Quality*, *User Satisfaction*, *Individual Impact*, and *Organizational Impact* of each dimension for these three approaches are respectively: integral planning and phased approach, integral planning and big-bang approach, and stepwise planning and phased approach. There is no significant difference in performance improvement levels of various performance evaluation dimensions except for the Information Quality ( $p < 0.1$ ) and System Use ( $p < 0.1$ ) dimensions between the companies with different ERP implementation strategies (Table 13). Significant differences exist between integral planning and phased approach and stepwise planning and phased approach. All these research results indicate that there is almost no significant difference in ERP performance improvement between the various approaches. However, if a company adopts the phased implementation, it should perform integral planning for all the ERP implementation phases.

Table 12 ERP performance indexes of “Ratio of improvement” (average, ranking, total ranking)

System Quality (n=283)		Ratio of improvement <sup>1</sup>		
		Average	Ranking	Total Ranking
S1.3	Data transmission	5.97	1	2
S1.2	The domain of database contents	5.94	2	3
S1.1	Data accuracy	5.90	3	4
S1.4	System accuracy	5.83	4	7
S1.5	Speed of system responses	5.81	5	8
Information Quality (n=283)		Ratio of improvement		
		Average	Ranking	Total Ranking
S2.2	Timeliness of information provision	5.88	1	5
S2.3	Usefulness of data provision	5.85	2	6
S2.1	Information believability	5.76	3	9
S2.4	Information understandability	5.61	4	12
S2.5	Importance of information related to decision making	5.40	5	17
System Use (n=283)		Ratio of improvement		
		Average	Ranking	Total Ranking
S3.4	Degree of voluntary use of the ERP system	5.76	1	9
S3.3	Frequency of the use of report/information	5.75	2	10
S3.5	Connection time	5.67	3	11
S3.1	Ratio of the use of the ERP system for decision support purposes	5.32	4	21
S3.2	The expenses of the ERP system shared by individual departments	4.90	5	30
User Satisfaction (n=283)		Ratio of improvement		
		Average	Ranking	Total Ranking
S4.1	Information satisfaction	5.43	1	16
S4.4	Overall satisfaction	5.28	2	22
S4.5	The ERP project satisfaction	5.23	3	25
S4.2	Software satisfaction	5.16	4	26
S4.3	System interface satisfaction	5.14	5	27
Individual Impact (n=283)		Ratio of improvement		
		Average	Ranking	Total Ranking
S5.1	Job performance	5.46	1	14
S5.2	Individual productivity	5.36	2	18
S5.3	Decision effectiveness	5.33	3	20
S5.5	Accurate readiness of problems	5.27	4	23
S5.4	Capability of problem identification	5.25	5	24
Organizational Impact (n=283)		Ratio of improvement		
		Average	Ranking	Total Ranking
Financial facets				
S6.1.1	Inventory levels	5.43	1	16
S6.1.2	Purchasing costs	5.36	2	19
S6.1.3	Inventory turnover	5.32	3	21
Customer facets				
		Average	Ranking	Total Ranking
S6.2.3	Ratio of on time delivery of bills	5.37	1	18
S6.2.1	Ratio of on time delivery of goods	5.10	2	28
S6.2.2	Response time to customer complaint	4.98	3	29
Internal business process facets				
		Average	Ranking	Total Ranking
S6.3.1	Internal data transmission time	6.05	1	1
S6.3.2	Frequency of interaction across departments	5.53	2	13
S6.3.3	Response time to environmental volatility	5.44	3	15
Learning and growth facets				
		Average	Ranking	Total Ranking
S6.4.1	Understanding on work flow	5.37	1	18
S6.4.2	Employees' job achievement	5.14	2	27
S6.4.3	Product development to the market	4.81	3	31

<Note> All “Ratio of improvement” were measured at a 7-point Likert-type scale ranging from 1 (substantial deteriorate) to 7 (substantial improvement).

Table 13 Scheffe Test for Implementation Strategies and Performance Improvement in Information Quality and System Use

Implementation Strategies (N=173)		Information Quality	System Use
Integral planning and Big-bang implementation approach (1)	(1)-(2)	-0.0924	-0.2120
	(1)-(3)	0.3496	0.2063
Integral planning and phased implementation approach (2)	(2)-(1)	0.0924	0.2120
	(2)-(3)	0.4420*	0.4183*
Stepwise planning and phased implementation approach (3)	(3)-(1)	-0.3496	-0.2063
	(3)-(2)	-0.4420*	-0.4183*

\*p-value < 0.1

Implementation strategies: 1 = 69 firms using integral planning and Big-bang implementation approach

2 = 75 firms using integral planning and phased implementation approach

3 = 28 firms using stepwise planning and phased implementation approach

### 3.4.3 Implementation ERP Statuses and Performance Improvement

Of the 283 companies that have successfully implemented ERP systems, 146 (51.59% of 283) have installed all the planned modules and 137 (48.41% of 283) have installed partial planned modules. From Table 14, we can see obviously that the average performance improvement levels on each performance evaluation dimension and composite performance are significantly different between these two groups. That is, the companies with implementation of all the planned modules tend to report higher performance improvement levels than the companies with implementation of partial planned modules. Successful implementation of all the planned modules seems more likely to help an adopting company optimize the synergistic effect of its ERP system.

Table 14 Implementation Statuses and Performance Improvement

	ERP status (N=283)	N	Mean	Std. Deviation	t-test for Equality of Means			
					t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
System Quality	1	143	6.02	0.78	2.682	0.008***	0.2796	0.1043
	2	121	5.74	0.91				
Information Quality	1	143	5.85	0.83	3.175	0.002***	0.3308	0.1042
	2	118	5.52	0.84				
System Use	1	142	5.58	0.76	2.145	0.033**	0.2068	0.0964
	2	121	5.37	0.80				
User Satisfaction	1	140	5.39	0.92	2.631	0.009***	0.3170	0.1205
	2	121	5.08	1.03				
Individual Impact	1	140	5.43	0.82	1.967	0.050**	0.2069	0.1052
	2	121	5.22	0.88				
Organization Impact	1	143	5.45	0.86	2.711	0.007***	0.2745	0.1013
	2	120	5.18	0.77				

\*(p<0.10), \*\*(p<0.05), \*\*\*(p<0.01)

ERP status: 1= 146 firms of all planned modules being successfully implemented

2= 137 firms of only parts of the planned modules being successfully implemented

### 3.4.4 ERP System Sources and Performance Improvement

The 283 adopting companies find their ERP systems in five major sources: evolution from legacy systems (41, 14.49%), self-redevelopment (25, 8.83), outsourcing (40, 14.13%), package ERP system (119, 42.05%), and package ERP system with other systems (54, 19.3%). The average performance improvement levels for these five system sources can be divided into two groups. The first group (106, 37.46%) that incorporates evolution from legacy system, in-house redevelopment, and outsourcing, register higher performance improvement level than the second group (173, 61.13%) that covers ERP package systems and ERP

package systems with other systems. One group is non-packaged ERP systems and the other one is packaged ERP systems. The average performance improvement levels on each performance evaluation dimension and composite performance are significantly different between these two groups ( $p < 0.001$ ). The companies with non-packaged ERP systems tend to sustain higher performance improvement levels than the companies with packaged ERP systems. This result is against our normal expectation, and the reason may lie in the fact that most of the companies implemented with packaged ERP systems in Taiwan are still on the early stage of post-implementation and have yet to achieve the full ERP benefits (Table 15).

Table 15 ERP system sources and Performance Improvement

	ERP system sources (N=283)	N	Mean	Std. Deviation	t-test for Equality of Means			
					t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
System Quality	1	99	6.07	0.73	2.771	0.006***	0.2991	0.1079
	2	162	5.77	0.91				
Information Quality	1	98	5.94	0.76	3.680	0.000***	0.3936	0.1070
	2	160	5.55	0.88				
System Use	1	99	5.71	0.77	3.740	0.000***	0.3668	0.0981
	2	161	5.34	0.77				
User Satisfaction	1	97	5.56	0.83	4.092	0.000***	0.5035	0.1230
	2	161	5.06	1.02				
Individual Impact	1	98	5.66	0.79	5.086	0.000***	0.5333	0.1048
	2	160	5.13	0.83				
Organization Impact	1	99	5.59	0.73	4.195	0.000***	0.4314	0.1028
	2	161	5.16	0.85				

\*( $p < 0.10$ ), \*\*( $p < 0.05$ ), \*\*\*( $p < 0.01$ )

ERP system sources: 1= 41 firms of evolution from legacy systems, 25 firms of in-house redevelopment, and 40 firms of outsourcing.

2= 119 firms of single ERP package, and 54 firms of a mixture of an ERP packages with other systems.

#### 4. Conclusions

This investigation systematically surveys the implementation status and experience of ERP systems by Taiwanese firms. Of the 657 usable responses returned, 283 respondents have successfully implemented ERP systems including 146 (22.22% of 657) having implemented all planned modules and 137 (20.85% of 657) having implemented parts of the planned modules. This paper focuses the analysis on these firms who have implemented ERP systems. Of the 283 firms with successfully implemented ERP systems, 173 (61.1% of 283) employ the packaged ERP systems. The packaged ERP systems frequently implemented are local ERP systems, and the modules frequently used are *Financial Accounting*, *Purchasing Management*, *Material Management*, *Sales Distribution*, *Fixed Asset Management*, and *Production Planning*.

CEO and CIO are the main internal drivers and ERP vendors are the most important implementation partners for packaged ERP system implementation in Taiwan. The top four ERP implementation problems, for packaged ERP system implementation in Taiwan, are: (1) failure to describe the requirements for the ERP system by departments; (2) The ERP system failing to meet the firm's requirements, and other add-on programs being necessary; (3) delay of the project implementation schedule; and (4) lack of ERP system to fit corporate process. Most of these problems are about whether packaged ERP systems fit corporate requirements and processes or not. This research result also indicates that management should determine whether to change its business processes to fit with the ERP system or to modify the ERP system to fit with the company's business processes.

The top two ERP post-implementation problems are: (1) insufficient education and training courses for employees, and (2) lack of performance evaluation periodically. From

this research result, we know that companies should provide training course opportunities on a continual basis to enhance their employees' skills and better prepare them to meet the changing needs of the business and their occupational duties (Bingi et al., 1999). Besides, this research result also indicates that most companies in Taiwan still in need of performance evaluation periodically during the ERP post-implementation stage. DeLone and McLean's IS success model (1992) can be used to execute performance evaluation during the ERP post-implementation stage. This research utilized DeLone and McLean's model (1992) and Balanced Scorecard (Kaplan and Norton, 1992) to develop 37 ERP performance measures to evaluate the performance improvement levels of 283 companies with successfully implemented ERP systems. The research results indicate that:

- (1) System Quality and Information Quality are the top two performance improvement dimensions in the post-implementation stage of ERP systems. These two dimensions are the fundamental factors of achieving ERP/IS success.
- (2) The companies with implementation of all the planned modules tend to register higher performance improvement levels than the companies implemented with only partial planned modules. Successful implementation of all the planned modules seems more likely to help an adopting company optimize the synergistic effect of its ERP system..
- (3) The companies with non-packaged ERP systems usually report higher performance improvement levels than the companies with packaged ERP systems.

No significant difference in ERP performance improvement has been detected between the various implementation strategies. However, if a company chooses to adopt the phased implementation, it should duly perform the integral planning job for all the ERP implementation phases.

This study examines critical management issues in ERP implementation and aims at demonstrating how its findings can be applied to understand the ERP implementation experience of Taiwanese firms. Our research results will be good references for companies intending to implement ERP systems in the future.

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