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Effect of Enterprise Resource Planning Information System on Business Performance: An Empirical Case of Taiwan

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Abstract

This paper develops a framework to evaluate the effect of Enterprise Resource Planning (ERP) system. By case study and expert interviews, this paper found that after introducing ERP, case company has intangible positive effects on reputations, decision quality, productivity, product quality. The company has improved business processes and business process reconstruction and organizational change continuously. By financial ratio analysis, this paper found tangible effects with significant improvement on five financial ratios.

JEL classification numbers: F15, F30
Keywords: Enterprise Resource Planning (ERP), Financial ratio analysis, Business Process Reengineering (BPR), Organizational Change Management (OCM)

1 Introduction

The twenty-first century is the era of information technology. With the development of information technology to accelerate corporate globalization, previous large standardization of product-oriented manufacturing has gradually been replaced by small customized customer- oriented one. At the time to emphasize business efficiency and customer service, cooperation between the upstream and downstream manufacturers has become closer and more complicated. Enterprise resource planning system, which is replaced by ERP hereafter, was born in this environment. Since ERP system starts to introduce, Taiwan high-tech and information industries have become a global production center. In recent years, due to the rapid development of ERP and pressure from the large-scale manufacturers, in order to obtain more orders, numerous multi-national

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companies continuously invested in ERP system, which becomes an important factor in the operation success.

Due to the complexity and diversity of ERP system, it is necessary to evaluate its effects by using a variety of research methods. Most prior studies for introducing ERP project consider qualitative or quantitative method alone. Karsak and Ozogul (2009) explore ERP software selection by using three quantitative technologies of decision making, i.e., quality function deployment (QFD), fuzzy linear regression and zero-one goal programming. Sen et al. (2009) presents a new decision support system to select suitable enterprise software. They use a hierarchical structure including both qualitative and quantitative objectives to evaluate software product. Motwani et. al. (2002) use two case studies to obtain the evidences of adopting ERP effects, including firm performance, product quality, costs, flexibility, and responsiveness. Unlike prior studies considering qualitative or quantitative method alone, this paper employs qualitative and quantitative method simultaneously, and develops a novel framework to evaluate the effects of introducing ERP system on business. Being different from these studies selecting right software to fit business process, this study focuses on the interaction between processes and ERP modules, for example, whether ERP software should be modified to fit internal process, or whether internal process need to be revised to reconcile with ERP functional modules. Through these process revisions, a company maybe leads to business process reconstruction and organizational change. These intangible effects are difficult to be measured by some financial figures such as costs and benefits. Specifically, at initial stage in introducing ERP system, few concrete evidences provide significant improvement in operational performance. Thus in additional to financial indicators analyses and T tests, this study uses qualitative method, i.e., case study and interview, to investigate the effect of introducing ERP system on operational performance. This study uses a bi-technology manufacture company as sample case and selects sample period spanning from 1999 to 2010. This paper measures tangible effects of introducing ERP by analyzing the change in financial performance ratios at both pre- and post-introducing periods. Alternatively, by using case study and interviews, this work interviews ERP team member to realize intangible benefits from introducing ERP system.

The study initially finds the motivation and research problems by reviewing prior literatures and theoretical discussion. Furthermore, this paper summarizes the intangible effects by conducting case study and interviewing with team members in the case company. This work proceeds to investigate the difference between pre- and post-introduction in five financial ratios by using ratio analysis and T test, and then proposes the tangible effects. This paper finally summarizes the tangible and intangible effects, and proposes the conclusions and implications.

2 Literature Review

2.1 Enterprise Resource Planning (ERP) Systems

ERP system, which supports the operations and business activities, can serve as the foundation for integrating business functions including marketing, production, logistics, distribution, accounting, finance, and human resources. ERP is developed by Germany's SAP Company which used database management techniques to integrate enterprise functions into a central database. Except for material resource planning, Mraz (2000)

define ERP as alternative value-added functions such as sales management, service, marketing functions. Norri (2000) suggested that ERP system is regard as a structure which can render company's internal value chain to optimize. Davenport (1998) proposed that ERP is a set of software modules which integrate relevant applications of enterprise management and cover the majority of operating procedures. The functions of ERP modules are helpful to implement manufacturing, finance, marketing, personnel, research & development functions. They form the calculation procedure based on a global financial system linked with all branches to conduct real-time analysis of product quality, customer satisfaction, and overall profitability. Hammer and Champy (1993) suggested that ERP is a family of software modules. Due to close integration of each module, it thus becomes a tool to support business processes. Park (2000) indicated complexity of ERP functions due to including numerous modules, which can be integrated in operation independently, such as BOM, MPS, MRP, financial accounting. Kalakota Ravi and Marcia Robinson (2001) assert that the ERP can alter corporate culture, organizational structure, business flow, employee attitude, or even daily working procedure. In response to the ERP introduction, a company can determine appropriate business processes and adjust the function of corporate structures through business reengineering process (BRP). Thus the setup time for ERP, which generally ranges from six months to three years, depends on the enterprise size. Standardization is another important character of ERP system, which includes total solutions in the package of each information technology factory. As such, ERP is not necessarily appropriate for the flow of business and its requirements. Therefore, it is necessary to establish a team to analyze enterprise process by consultants to explore whether ERP is properly applied and work flow should be improved, and consider whether investing ERP can lead to anticipated effects (Norris, 2000; Park, 2000). Considering the cost and risk, Kalakota R. and M. Robinson (2001) propose three ways to introduce ERP. First, all modules are induced at one time. Second, a module is introduced once at a time. The gradual steps can avoid sharp changing and risk. Thirdly, to choose a business field and introduce some modules related to this field at a time. Langenwalter (2000) proposed the steps to decide the appropriate vendors: Create vision, create future function list, create candidate list, narrow the field to several suppliers, request for proposal, to select the best three suppliers, demo products, select winner plan implementation.

2.2 Tangible and Intangible Benefits of ERP Systems

Over the past two decade, the effects of ERP system have been explored continuously. Kremzar & Wallace (2001) assert that as numerous tangible and intangible benefits and strategic reasons exist, it is popular to choose and deploy ERP system for organizations. Davenport (1998) suggests that the benefits of conducting ERP system are worthwhile in spite of its high cost and time-consuming. Motwani et. al.(2002) address that adopting ERP leads to both business process changes and information technology changes to enhance firm performance, product quality, costs, flexibility, and responsiveness. Elaine and Lopez (1997) assert intangible benefits of ERP systems including production automation and improve productivity. Employees reduce costs to coordinate and share information. These benefits can be characterized as three categories. First, to enhance internal efficiency such as reducing inventory levels, integrating internal processes and information system. Second, external efficiency is indicated as reducing shipping time, responding to customer demand quickly, which can provide a link of external

organizations and strengthen global logistics or e-commerce capabilities. Thirdly, ERP provides the effect on accuracy of real-time information. Huber (1990) proposed intangible benefits related to internal integration include information and processes, and customer service improvement. Tangible benefits related to cost efficiencies in inventory, personnel, procurement and accounting, as well as improvements of productivity, cash and order management, and overall profitability. For intangible benefits, Hammer and Champy (1993) defines business process reconstruction (hereafter BPR) as a fundamental rethinking of procedure which thoroughly refurbishes operating process to improve operating cost, service, quality and speed. AlBanna and Osterhaus (1998) suggest that business reconstruction to introducing ERP include information system reconstruction, business process reconstruction, and business organization reconstruction, which lead to flow redesigns from overall aspects such as products, customers, employees, technology, processes and other dimensions including how to increase process value, integrate resources, develop multi-functional work team, and improve customer service. Prior literatures also suggest that while inducing the ERP system, a company often faces with the problems whether internal process need to be modified. Bradley et al.(1999) asserts that if ERP system owns more flexibility and adjustment according to company features, it will be introduced faster than others. Flexibility determines whether ERP system operates quickly. If ERP system cannot adapt to a company processes, it will be necessary to modifying both software and process and to update future ERP system versions. As a result, ERP can lead to organizational change (hereafter OC), which means revision or adjustment in organizational structure and process design. Also, the effect of any single OC is not only limited to change itself, but is likely to expand to other larger OC.

2.3 ERP System and Firm Performance

Over the past one decade, previous works often measure financial performance as tangible effects of ERP. Hunton et al. (2003) indicate that return on assets (ROA), return on investment (ROI), and asset turnover were significantly better over a 3-year period for ERP system adopters, as compared to nonadopters. Specifically, they found a positive (negative) relationship between financial health and performance for small (large) firms. Their findings suggest that ERP adoption helps firms gain a competitive advantage over nonadopters. Poston and Grabski (2001) investigated the impact of ERP system implementation on firm performance. Umble et al. (2003) use a case study to identify successful factors to ERP implementation. Among these factors, the performance measures are considered to be most important[2]. Fisher & Chi (2004) employ DEA approach to analyze and compare the ERP performance. Their evaluations are based on information provided by ERP vendors. Teyarachakul (2006) uses case study to investigate how DEA can be applied for ERP performance evaluation. Wier et al. (2007) asserts that joint adoption of ERP systems and non-financial performance incentives (NFPI) will yield greater firm performance than either ERP or NFPI alone.

[2]Other factors such as clear understanding of strategic goals, commitment by top management, project management, organizational change management, a great implementation team, data accuracy, extensive education and training.

3 Research Method

Based on post literature review, this article first identifies research problems, and then uses case study (qualitative research method) and interview method to analyze intangible benefits. By collecting financial data from a Taiwan bio-technology manufacture's company from 1999 to 2010, this study then evaluates the tangible benefits of the ERP system by financial ratio analysis and T tests. Adopting data analyses of Miles and Huberman (1994) including three stages, data reduction, data display and derivation of research conclusions[3], thus this work refers to this principle to conduct information analysis and obtain results of tangible effect. Through research framework Figure 1, this study aims to explore whether organization efficiency is enhanced after the introduction of ERP.

3.1 Qualitative Research Method: Case Study

During the period of introducing ERP, business internal process may be revised to fit ERP modules. Through these process revisions, a company may be lead to business process reconstruction and organizational change. These intangible effects are difficult to be measured by some financial figures such as costs and revenues. Thus in additional to financial indicators analyses, this study uses qualitative method, i.e., case study and interview, to investigate the intangible effect of introducing ERP system. The interviewees are project members from finance, IT, production management, procurement, marketing, and human resources departments of this company who are involved in ERP introduction. A case interview procedure is designed as follows. First, to identify benefits from the industry environment, this study selects a company of bi-technology industry to conduct interviews. The interviewees are members from the finance, information, production, procurement, marketing and other departments who participate in the ERP set-up work. Second, according to research subject, this work designs interview questions proposed by structural form, so as to collect data and then summarize the result. Thirdly, regarding case study process, prior to the case interview, this work first surveys the industry background of this sample company, and interviews members from the company various departments who participate in ERP system project. In order to allow interviewees sufficient time to understand the purpose of this study, after making appointment with them, I provide subjects and relevant information to the interviewees prior to the interview. If the interviewees have any questions, they can obtain answers before or during the interviews. The interviewers depend on interview outlines as the base. In order to completely present the real operation of the ERP project, this study used a variety of sources such as relevant literature, information provided by interviewees, observations and cognitions of the interviewers to increase the construct validity of the information. During the interviews, interviews records are kept by taking notes and recording. The interviewees provide the developing process of the ERP system project including the project schedule, phases of each project module and the tool methods, the interaction of

[3]Data reduction refers to use summary, title, and code to present information system after display great amount of research data. Information display refers to convey complicated information by timetable, flow chart, matrices, and a variety of ways. As to the conclusions derived, it can proceed via phenomenon comparison, interpretation, time series analysis, and manners such as the logic model planning.

members during the project development, organizational environment, degree of support from this sample company. After the interview, the study summaries and analyzes contents of the interviews, and post-mails the result to the interviewees for confirmation to enhance the validity of the data, which can become analysis base in this study.

3.2 Quantitative Research Method

3.2.1 Financial ratio analysis

Most tangible benefits of ERP system are reflected in the financial statements. The comparison among a series of financial conditions of case company can reflect future prospects. Five financial ratio testing is the most widely used financial analysis tool, which reveals the relationship between various financial projects and practical figures to enable investors easily understand financial results. Therefore, this study uses five sets of financial ratios to test financial performance during the periods of ERP pre- and pro-introduction for the case company. Five financial indicators are financial structure, operation capacity, short-term solvency, profitability, cash flow. Through comparing the change in financial ratios after introducing ERP, this paper would observe weather this sample company would improve financial performance.

3.2.2 T test and statistical analysis

To study whether the difference between pre and post-introducing ERP in business performance occurs in the Taiwan bi-technology company, by collecting five financial indicators data, this work conducts T tests and performs statistical analysis.

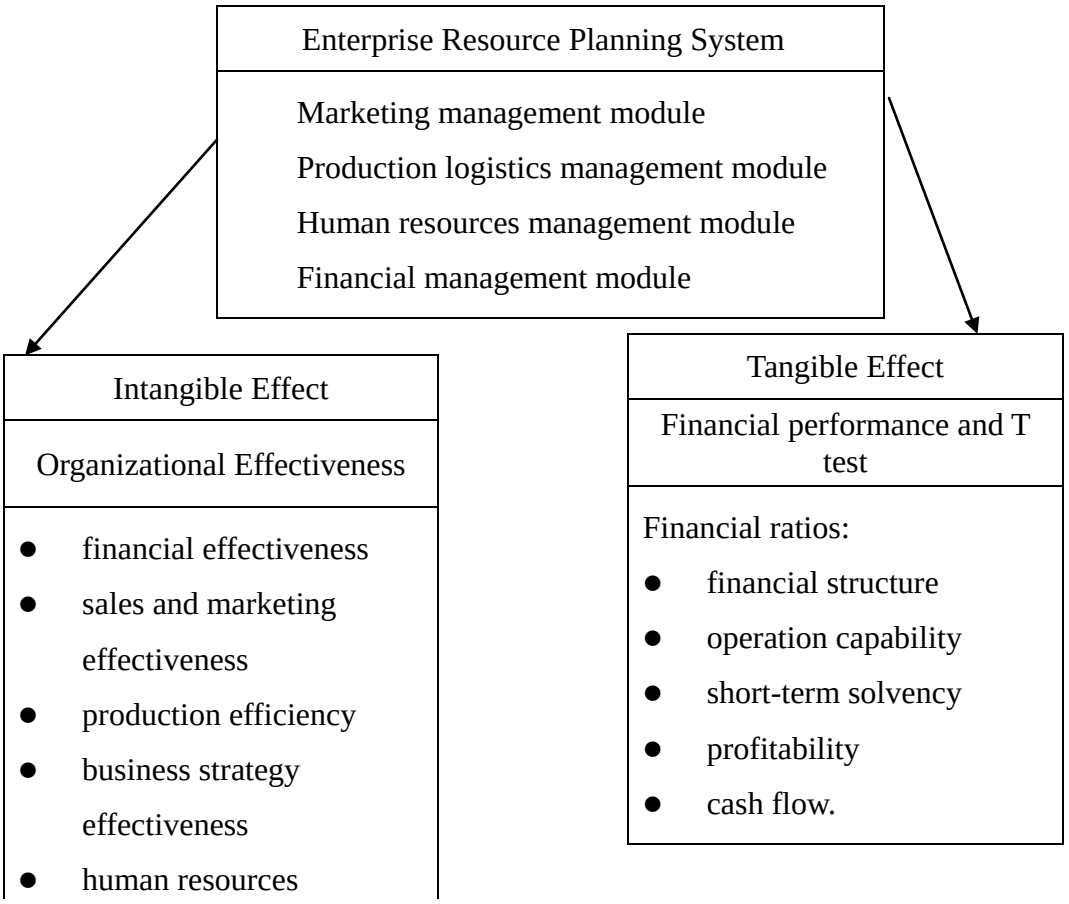

Figure 1: The effect of ERP system on corporate performance

4 Results

Miles and Huberman (1994) mentioned that data analysis should include three stages: data simplification, data display and derivation of research conclusions. Data simplification refers to use abstract, title, and coding to present data content by structural form. Information display refers to convey complicated information by a variety of ways such as timetable, flow chart, matrices. As for the derivation of conclusions, it can proceed via phenomenon comparison, interpretation, and some methodologies such as time series analysis and logic model planning. Based on above approach, after implementing the interview and case study, this work further summarizes and analyzes information collected from interview and case study.

4.1 Case evidence of ERP project in T Company

4.1.1 Case background

This study's sample case, T Company, is a bi-technology manufacturer with headquarters located in the Hsinchu Science Park and modern professional bi-technology factories. Its main products, including health care food, health protection food, medical pharmaceuticals, are widely used by various customers, who spread in the United States, Japan, China, South Korea, Taiwan, Europe, India and other countries. Its sales have reached 3,759 billion dollars in 2010 from was 12.3 billion in 1995 with steadily growing year after year. Its management philosophy emphasizes on product quality, and corporate culture that strives for perfection and constantly improves to ensure overall customer satisfaction. There is only one essential goal in common: zero defects in everything. As disadvantages have not faded out, T Company is willing to take various measures to isolate customers from "unwholesome" or "inconvenience", and requires all employees to cooperate and work together to improve production quality.

4.1.2 ERP project scope and planning

T Company's information operation system can be divided into two parts: front-and back-end systems. The former is a trading platform to communicate with customers through a large number of applications for web and software such as IT tools so as to make the relationship between T Company and customers closer. Back-end system make upstream and downstream processes between supply chains connect closely and continuously, so that T Company can conduct optimal production planning, optimal productive schedule and raw material procurement. Operation system of T Company starts from back-end system, so it introduces the ERP system based on three stages, the Total Order Management (TOM), Business Process Reengineering (BPR), Enterprise Resource Planning (ERP). Regarding the buildup for ERP project, in 1997, T Company proposes corporate integration information system project (CIS). During 1997~2001, first stage of CIS system starts planning for Total Ordering Management (TOM) in 1997, introducing it in 1999 and formally online in 2001. In 1999, second stage of CIS proceeds with BPR and Information Technology (IT) planning. In order to continue improving upstream and downstream process within the company, T Company cooperates with Consulting Firm in 1999 with rebuild activity of business flow. Based on this, the blueprint for future IT system introduction was build up. During 2001~2003, the third stage of CIS executes the project of ERP system. ERP was completed on line in January, 2002, including six categories such as finance, procurement, inventory management, order management, profit analysis. Product Information Data Base (PIDB) was online in 1999, which proceeded with revision in 2001, and formally practice new version in 2003. In 2004, productive control department takes the responsibility of productive plan with electronic in 2004.

4.1.3 Evaluation of infrastructure development

As the introduction of ERP system exactly fulfills T Company's business goal and strategy, this makes director and staff to support new system project with future benefits. When T Company faces a major change resulting from IT system introducing, the trainings are held to fully communicate with the staff. Then the concept of IT process with better communication was introduced in training lessen. Furthermore it provides efficient

training to make employee be familiar with new ERP system to work. To be important, Leader of each sub-project in T Company are directors of relevant functions rather than IT departments. This makes user departments regard the project as their own work and take most of the responsibility. As such, they will actively accomplish ERP project under communicating with IT sector fully. In addition, consulting firm has tremendous impact on the induction of methodology, process design, parameter setting, and even in custom programming. It also has considerable influence on the educational training of MIS staff. As for selecting consulting firm, based on three criteria, first is the size of the company, which relates to sufficient manpower to support. Second, the consulting firm's areas of expertise. Third, the man assigned by consulting firm has experience and ability sufficient to complete this task. As the time for T Company to introduce the ERP was not long, effects of ERP will not appear until it has been in operation for a long time, or manufacturing process began improving.

4.2 Intangible Benefits from Qualitative Method

Through case study and interviews, this work finds several intangible benefits of introducing ERP system. First, ERP system provides a platform which allows user to complete operational transactions by connecting various modules. A company thus can save IT budgets without purchasing separate systems for various functions to consider the problem of interface integration. Second, without a variety of materials reorganization, ERP system makes integration of financial transactions, which enable executives and financial directors to compare easily. A variety of reporting tools provide them the necessary and most real time information. Third, through connecting various modules, integration functions of ERP reduce time for manual repetitive key-in data. An employee can find information for related modules within the system to reduce time for information inquiry and transmission across the departments. Fourth, ERP modules provide the interface about market data, which can effectively establish customer database and data analysis, which are helpful to execute marketing strategies. Five, ERP module provides a variety of access control. According to the position level of project members, it set permissive access authority to establish and read data at different levels.

After the introduction of ERP system, T Company completes three types of reengineering. First, Information system reengineering, for example, original information system is replaced by new information system, enhancing the effectiveness of application information system, establishing a unified enterprise information system framework. Second, business process reengineering, implying that by developing new processes, ERP can integrate original scattered processes and improve efficiency and quality of decision making. With streamlined and effective new process, T Company can respond quickly to changes in the competitive environment. Third, corporate reorganization implies that by introducing ERP system, T Company can achieve corporate strategic objectives. With enterprise vision realization, the organizational culture and innovation capability in the company have been improved thoroughly.

This study also provides numerous intangible effects of introducing ERP system in T Company in agreement with Motwani et al. (2002)[4], for example, improving productivity

[4]Motwani et al., (2002) address that adopting ERP originates both business process changes and information technology changes to enhance performance, product quality, costs, flexibility, and responsiveness.

and quality of decision making, shortening decision-making time, improving job quality. Furthermore, ERP system improves firm competitive advantage, and increases sales revenue and reputation. In term of sales aspect, ERP system can instantly solve customer problems, and satisfy customer needs. For human resource management, by using ERP system, this case company can enhance their employee self-development. In introduction process, employees can learn new knowledge and technology, and benefited from promotion in this company. Moreover, ERP system improves procurement and production process, and other procedures, i.e., supplier delivery, product quality, pricing, order processing time significantly. In term of accounting, ERP system can save accounting time, and improve billing process, accounting quality.

4.3 Tangible Benefits from Financial Ratio Analyses

This study uses financial ratio indicators to analyze effectiveness of the introduction of ERP system for the case company. The results of the five financial indicators are as follows:

1. Financial structure

During the induction period, debt to asset ratio has decreased year by year. It was 31.85% in 1999, 29.74% in 2000, and it even dropped to 35.03% in 2001. After introducing ERP, the ratio decreased further to 19.85% in 2006. Although it slightly increased by 3% in 2007, it again decreased to 18.17% in 2008, which was the lowest. It indicated that after introducing ERP, the overall financial structure had improved gradually. Ratio of long-term funds to fixed assets increased annually from 139.76% in 2005 to 210.78% in 2010. The ratio increased to 61%, also the highest in previous years. It showed that after inducting the enterprise resource planning system, the ability of the long-term capital of the company to support fixed assets have improved significantly.

Table 1: The result of financial structure ratio

financial structure ratio	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
debt to asset ratio (%)	31.85	29.74	35.03	37.53	28.18	20.13	22.64	19.85	20.78	18.17	11.45	10.65
long-term capital to fixed asset ratio (%)	136.89	128.77	115.94	148.16	168.17	140.46	139.76	154.3	189.53	175.42	205.42	210.78

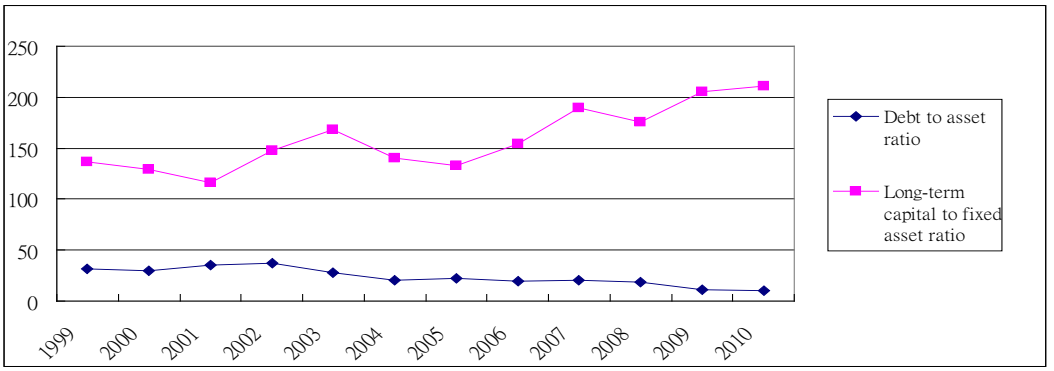

Figure 2: 1999~2010 financial structure ratios trend

2. Operation capability

The higher turnover ratio of receivable account, the stronger the ability to claim the receivable account. It suggests that the shorter the period to claim amount, the more flexible the use of funds. After the project ended in 2002, the initial benefit have not yet emerged out. During 2003~2005, the receivable turnover rate decreased continuously. From 2005 to 2006, the trend obviously turned upwards with the increasing rate at 9.08%, which is the highest for the past years. The higher is inventory turnover, the lower the inventory level. Although a clear upward with improving rate up to 8.02% from 2002 to 2003, the inventory turnover fell from 2004 to 2005 because the benefit had not yet appeared at initial introducing stage. This result suggests that after introducing ERP system, T Company's inventory management makes obvious progress. Other two financial indicators, i.e., fixed asset turnover, total asset turnover, also increased significantly.

Table 2: The result of operation capability ratio

operation capability ratio (%)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
receivables turnover	9.12	8.75	5.75	6.75	8.92	7.87	5.32	9.08	8.45	9.05	9.15	10.65
inventory turnover	7.59	6.85	6.52	6.82	8.02	10.12	9.19	11.05	10.45	11.63	12.45	12.05
fixed asset turnover	1.08	1.48	1.05	0.68	1.48	0.80	1.06	1.75	1.07	1.45	1.96	1.85
total assets turnover	0.60	0.54	0.41	0.40	0.45	0.49	0.37	0.44	0.51	0.53	0.52	0.55

Figure 3: 1999~2010 operation capability ratios trend (Table 2,Figure 3)

3. Short-term solvency

With regard to two financial indicators of short-term solvency, there are considerable changes for both the current ratio and acid test ratio. When the ERP system was online in 2002, the current ratio has gradually increased year after year up to 454.51% in 2009. Similarly, the acid test ratio also follows the same patterns. These suggest short-term solvency improved significantly.

Table 3: The result of short-term solvency ratio

short-term solvency ratio (%)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
current ratio	325.64	317.54	255.87	324.11	268.78	248.75	253.48	284.51	384.54	355.45	454.51	452.45
acid test ratio	257.83	247.77	185.78	273.86	233.95	178.13	211.92	264.11	478.38	425.24	485.45	494.87
times interest earned ratio	32.45	42.40	32.04	8.91	14.83	34.02	15.84	12.79	30.67	39.62	57.85	65.87

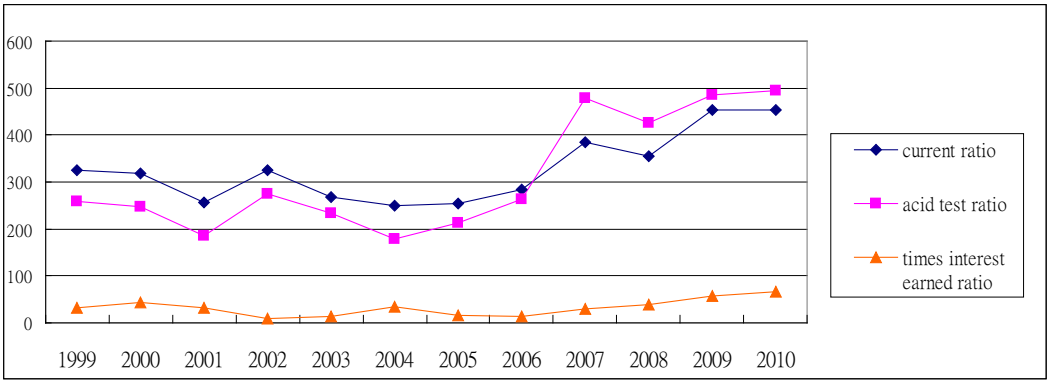

Figure 4: 1999~2010 short-term solvency ratios trend

4. Profitability

During the introducing ERP period between 1999 and 2002, due to the impact by considerable demand of global market, these profitability ratios were gradually falling year after year. Since 2002, the ERP system was set up completely on line, leading to process reengineering, this company increases earnings per share and profit margin year by year, which even increased to 47.89 % in 2010. After the ERP on line in 2002, earnings per share ranged between 5.33 and 15.74 from 2003 to 2010, more than the figures before on-line.

Table 4: The result of profitability ratio

profitability ratio (%)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
return on total asset	42.35	33.45	21.37	16.45	19.25	22.43	18.54	12.65	13.85	20.86	21.38	23.67
return on equity	57.55	45.28	29.56	19.99	23.98	31.43	30.37	27.54	35.12	32.36	22.16	26.64
NOPAT/capital ratio	86.57	61.48	58.54	44.62	64.52	67.84	72.54	72.87	76.88	84.57	93.57	95.85
EBT/capital ratio	99.48	71.48	68.54	54.62	64.52	62.53	70.45	74.85	82.42	83.57	90.54	92.45
profit margin	50.44	48.49	39.89	31.54	34.58	40.17	35.57	38.84	39.97	42.38	45.92	47.89
Earnings per share	10.48	7.31	11.48	13.89	15.74	11.84	8.83	6.14	5.33	6.78	7.88	9.75

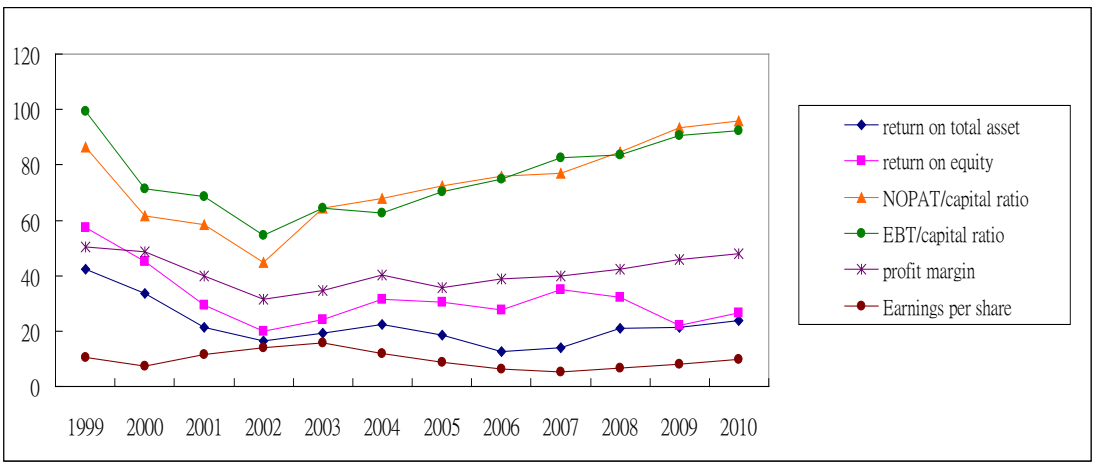

Figure 5: 1999~2010 profitability ratio trend

5. Cash flow

Cash flow ratio is an indicator of the immediate solvency of a company. When ERP is on line in 2002, cash flow ratio initially declines a little, yet start rising from 2005. During 2007~2009, cash flow ratio significantly climbs up to the highest point 467.55 % in 2009, which implies cash capacity in T Company to be improved fully. Similarly, cash flow adequacy ratio also rises up slowly. However, cash reinvestment ratio presents steady level, suggesting that after ERP set up on-line, T Company did not alter cash reinvestment with conservative policy as before.

Table 5: The result of cash flow ratio

Cash flow ratio (%)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cash flow ratio	348.48	452.74	395.12	417.56	37.85	302.45	312.45	332.45	355.85	365.85	467.55	457.01
Cash flow adequacy ratio	111.94	113.70	97.96	102.04	106.00	106.15	105.73	122.72	145.42	147.52	150.84	153.75
Cash reinvestment ratio	31.94	28.21	16.28	21.65	19.31	22.53	21.54	17.88	18.94	19.45	20.45	21.45

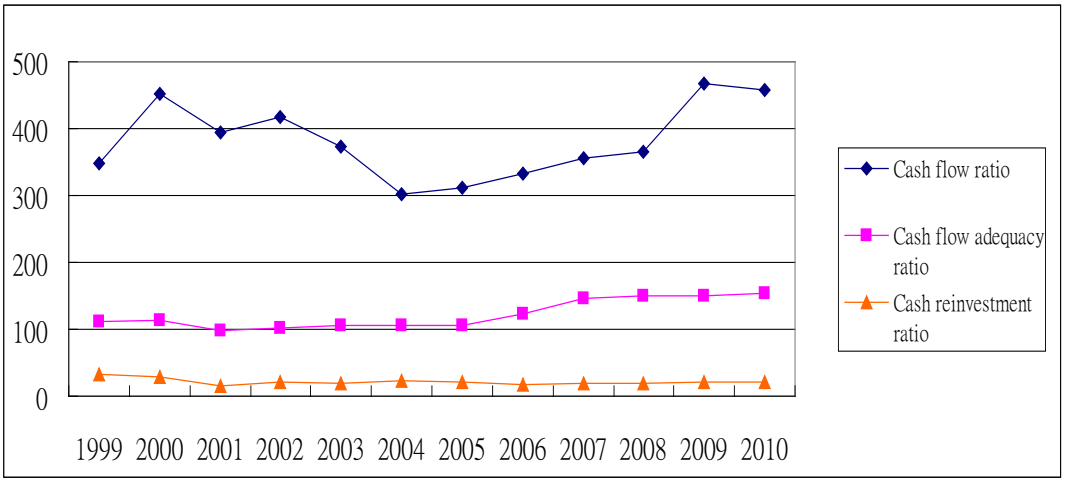

Figure 6: 1999~2010 cash flow ratio trend

4.4 T Tests of Financial Performance Indicators

This work conducts T tests for financial indicators to study whether the difference between pre and post-introducing ERP in business performance occurs in the Taiwan bi-technology company. The findings are given as follows.

1. The difference between pre- and post-introduction in financial structure ratio
Table 6 reports T test results of financial structure ratio. Significant difference occurs between pre- and post t+9-introducing (p=0.018) in debt to asset ratio at 5% significant level. No significant differences between pre- & post t+5 and between pre- & post t+7 tend to be found. Debt to asset ratio declines significantly from 30.98 of pre-introducing average to 10.65 in 2010. Three differences between pre- and post-introducing, i.e., pre- & post t+5, pre-& post t+7, pre-& post t+9, all present to be significant at 1% significant level (p=0.000) in long term capital to fixed asset ratio, which presents a significant increase.

Table 6: T-tests for financial structure ratio

financial ratio	pre	post (t+1)	post (t+3)	post (t+5)	post (t+7)	post (t+9)	pre & post (t+5) t value (*p* value)	pre & post (t+7) t value (*p* value)	pre & post (t+9) t value (*p* value)
DAR	30.975	37.53	20.13	19.85	18.17	10.65	-1.733 (0.111)	1.476 (0.168)	-2.775 (0.018)**
LTCFAR	132.83	148.16	140.46	154.30	175.42	210.78	-49.563 (0.000)***	-57.541 (0.000)***	-43.452 (0.000)***

Note: DAR denotes debt to asset ratio, LTCFAR denotes long term capital to fixed asset ratio, and pre denotes average performance for time periods -2 through -1. Post (t+1), post (t+3), post (t+5), post (t+7), post (t+9) denote performance indicators for one, three, five, seven, nine year after t year of ERP on-line. t value and *p* value denote the tests statistic values of difference between financial performance indicators of pre and post (t+1), post (t+3), post (t+5), post (t+7), post (t+9) introducing year respectively. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. denote 10%, 5%, 1% significant level respectively.

2. The difference between pre- and post-introduction in operation capability ratio

Table 7 reports T test results of operation capability ratio. Two significant differences occur between pre- and post t+7, between pre- and post t+9, in ITR (p=0.002, 0.045) and FATR (p=0.001, 0.000) at 1% and 5% significant level while no significant difference between pre- and post t+5 is found. This shows that ITR and FATR increase significantly since seven years after introduction. RTR only presents significant difference between pre and post t+9 (p=0.006) at 1% significant level while no significant differences between pre and post t+5, between pre and post t+7 occur. This indicates that RTR tends to go up significantly since nine years after introducing. Except for TATR, other three ratios all exhibit a significant upward movement.

Table 7: T-tests for operation capability ratio

financial ratio	pre	post (t+1)	post (t+3)	post (t+5)	post (t+7)	post (t+9)	pre & post (t+5) t value (*p* value)	pre & post (t+7) t value (*p* value)	pre & post (t+9) t value (*p* value)
RTR	8.94	6.75	7.87	9.08	9.05	10.65	0.820 (0.429)	-1.541 (0.151)	3.314 (0.006)***
ITR	7.40	6.82	10.12	11.05	11.63	12.05	-1.116 (0.288)	4.185 (0.002)***	2.257 (0.045)**
FATR	1.28	0.68	0.80	1.75	1.45	1.85	-1.430 (0.180)	4.263 (0.001)***	5.268 (0.000)***
TATR	0.57	0.40	0.49	0.44	0.53	0.55	-4.255 (0.001)***	1.694 (0.118)	4.172 (0.002)***

Note: RTR denotes receivables turnover ratio, ITR denotes inventory turnover ratio, FATR denotes fixed asset turnover ratio, TATR denotes total assets turnover ratio, and pre denotes average performance for time periods -2 through -1. Post (t+1), post (t+3), post (t+5), post (t+7), post (t+9) denote performance indicators for one, three, five, seven, nine year after t year of ERP on-line. t value and *p* value denote the tests statistic values of difference between financial performance indicators of pre and post (t+1), post (t+3), post (t+5), post (t+7), post (t+9) introducing year respectively. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ denote 10%, 5%, 1% significant level respectively.

3. The difference between pre- and post-introduction in short-term solvency ratio
Table 8 reports T test results of short-term solvency ratio. Two significant differences between pre and post t+7, between pre and post t+9 in CR (p=0.003, 0.018) and TIER (p=0.000, 0.005) occur at 1% significant level while difference between pre- and post t+5 tends to be insignificant. This indicates that CR and TIER go up significantly since seven years after introduction. ATR shows significant difference between pre and post t+9 ((p=0.051) at 5 % significant level. Other two test results of difference between pre and post t+5, between pre and post t+7 are insignificant. This implies that ATR has a significant increase since nine years after introduction.

Table 8: T-tests for short-term solvency ratio

financial ratio	pre	post (t+1)	post (t+3)	post (t+5)	post (t+7)	post (t+9)	pre & post (t+5)	pre & post (t+7)	pre & post (t+9)
							t value (p value)	t value (p value)	t value (p value)
CR	321.59	324.11	248.75	284.51	355.45	452.45	0.264 (0.796)	3.739 (0.003)***	2.784 (0.018)***
ATR	252.81	273.86	178.13	264.11	425.24	494.87	1.659 (0.125)	1.063 (0.310)	2.193 (0.051)***
TIER	37.425	8.91	34.02	12.79	39.62	65.87	-1.008 (0.335)	4.573 (0.000)***	3.414 (0.005)**

Note: CR denotes current ratio, ATR denotes acid test ratio, TIER denotes times interest earned ratio, and pre denotes average performance for time periods -2 through -1. Post (t+1), post (t+3), post (t+5), post (t+7), post (t+9) denote performance indicators for one, three, five, seven, nine year after t year of ERP on-line. t value and p value denote the tests statistic values of difference between financial performance indicators of pre and post (t+1), post (t+3), post (t+5), post (t+7), post (t+9) introducing year respectively. * p < 0.1, ** p < 0.05, *** p < 0.01 denote 10%, 5%, 1% significant level respectively.

4. The difference between pre- and post-introduction in profitability ratio
Table 9 reports T test results of profitability ratio. Three differences between pre and post t+5, between pre and post t+7, between pre and post t+9 in four financial indicators, ROA, ROE, PM, EPS occur at 1% and 5% significant level. Of four indicators, only EPS goes up toward 2010. Two differences between pre and post t+7, between pre and post t+9 in NCR and ECR occur at 1%, 5%, 10% significant level. This indicates that NCR and ECR rise significantly since seven years after introduction.

Table 9: T-test for profitability ratio

financial ratio	pre	post (t+1)	post (t+3)	post (t+5)	post (t+7)	post (t+9)	pre & post (t+5)	pre & post (t+7)	pre & post (t+9)
							t value (*p* value)	t value (*p* value)	t value (*p* value)
ROA	37.91	16.45	22.43	12.65	20.86	23.67	1.229 (0.047)**	2.401 (0.035)**	-6.574 (0.000)***
ROE	51.42	19.99	31.43	27.54	32.36	26.64	2.602 (0.025)**	3.925 (0.002)***	-6.491 (0.000)***
NCR	74.03	44.62	67.84	75.87	84.54	95.85	-0.104 (0.918)	2.067 (0.063)*	6.615 (0.000)***
ECR	85.48	54.62	62.53	74.85	83.57	92.45	3.016 (0.012)***	-2.356 (0.038)**	5.553 (0.000)***
PM	49.47	31.54	40.17	38.84	42.38	47.89	3.936 (0.002)***	5.715 (0.000)***	-4.774 (0.000)***
EPS	8.89	13.89	11.84	6.14	6.78	9.75	14.961 (0.000)***	16.043 (0.000)***	18.965 (0.000)***

Note: NCR denotes NOPAT/capital ratio, ECR denotes EBIT/capital ratio, PM denotes profit margin, EPS denotes Earnings per share, and pre denotes average performance for time periods -2 through -1. Post (t+1), post (t+3), post (t+5), post (t+7), post (t+9) denote performance indicators for one, three, five, seven, nine year after t year of ERP on-line. t value and *p* value denote the tests statistic values of difference between financial performance indicators of pre and post (t+1), post (t+3), post (t+5), post (t+7), post (t+9) introducing year respectively. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ denote 10%, 5%, 1% significant level respectively.

5. The difference between pre- and post-introduction in cash flow ratio

Table 10 reports T test results of cash flow ratios. Three significant differences between pre and post t+5, between pre and post t+7, between pre and post t+9 occur in two indicators—CFR, CRR at 1%, 5%, 10% significant level. CFR shows to rise significantly up to 457.01 in 2010 beyond 400.61 of pre-introduction since it are seven years after introduction.

Table 10: T-test for cash flow ratio

financial ratio	pre	post (t+1)	post (t+3)	post (t+5)	post (t+7)	post (t+9)	pre & post (t+5)	pre & post (t+7)	pre & post (t+9)
							t value (*p* value)	t value (*p* value)	t value (*p* value)
CFR	400.61	417.56	302.45	332.45	365.85	457.01	0.486 (0.036)*	-2.193 (0.051)**	4.862 (0.000)***
CFAR	112.82	102.04	106.15	122.72	149.94	153.75	1.508 (0.159)	3.244 (0.007)***	2.606 (0.024)**
CRR	30.08	21.65	22.53	17.88	19.45	21.45	1.835 (0.094)*	-0.011 (0.091)*	-6.667 (0.000)***

Note: CFR denotes cash flow ratio, CFAR denotes cash flow adequacy ratio, CRR denotes cash reinvestment ratio, and pre denotes average performance for time periods -2 through -1. Post (t+1), post (t+3), post (t+5), post (t+7), post (t+9) denote performance indicators for one, three, five, seven, nine year after t year of ERP on-line. t value and *p* value denote the tests statistic values of difference between financial performance indicators of pre and post (t+1), post (t+3), post (t+5), post (t+7), post (t+9) introducing year respectively. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ denote 10%, 5%, 1% significant level respectively.

5 Conclusions

This study investigates the effects of introducing ERP system on firm performance in a Taiwan bi-technology company. After conducting case study, interview, financial ratio analysis and T-test, some findings are proposed. First, by case studying and interviewing case company, the introduction of ERP system can enhance reputation of case company. Given that there is no such a complete information system, it would be difficult to face competition from world markets. Second, numerous intangible effects of introducing ERP system were found, in agreement with Motwani et al. (2002), i.e., improving productivity and quality of decision making, shortening decision-making time, improving job quality, increasing sales revenue, and satisfying customer needs instantly. In introduction process, case company can make employees learn new knowledge and technology, and enhance employee self-development, and benefit from promotion in this company. Moreover, procurement and production process were improved. Other procedures, i.e., supplier delivery, product quality, pricing, order processing, also were enhanced significantly. In addition, because of ERP system introduction, accounting time and billing process time were all shortened. ERP software has been continuously modified to fit internal process, which are also revised to reconcile with ERP functional modules. Through process revisions, the case company realizes business process reconstruction and organizational change. Third, by analyzing five financial ratio indicators, tangible effects are found that when comparing five financial ratio indicators of pre- with post- introducing ERP stages, those indicators have mostly improved distinctly. Through T test, the difference between pre- and post-introduction in these five financial indicators significantly occurs in the case company. Most significant differences occur in three years after introduction. Four, for case company, effect of introducing ERP system was not expected to emerge out immediately, because during initial online stage, the effect of ERP system would not fully appear until it operates for three years after introduction. In summary, through qualitative and quantitative method, this work's findings provide new insight into theoretical and practical implications. For practical implication, tangible and intangible effects of introducing ERP system can enhance investors' confidence in the company and make stock price evaluated reasonably. In this case company, process revision and improvement resulting from ERP introduction nearly reconcile with two theories, BPR of Hammer & Champy (1993), and OC of Bradley et al. (1999). After introducing ERP system, ROA and ROE have improved significantly, and are better over a 3-year period after introduction in favor of empirical findings of Hunton et al. (2003). Future researches can use non-financial performance indicators to evaluate effects of introducing ERP system on this case company completely.

References

[1] Albanna, Sami J.; & Joe Osterhaus. (1998). Meeting the software challenge: A Model for is transformation. *Information Systems Management*, **15**(1), 1-9.

[2] Bradley,P., Thomas,J., Gooley,T., & Cooke, J.A. (1999). Average ERP installation said to be a two-year ordeal. *Logistics Online: Management and Distribution Report*, **38**(5), 23-24.

[3] Davenport, T. H. (1998). Putting the enterprise into the enterprise system. *Harvard Business Review*, **76**(4), 121-131.

[4] Elaine, A., & Lopez, P. Z. (1997). Total quality management versus business process re- engineering. *Total Quality Management*, **8**(1), 33-39.
[5] Fisher, D. M., Kiang, M. Y., Fisher, S. A., & Chi, R. T. (2004). Evaluating mid-level ERP software. *Journal of Computer Information Systems,* 38–45.
[6] Huber, G. P. (1990). A theory of the effects of advanced information technologies organization design intelligence, and decision marking. *Academy of Management Review,* **15**(1), 47-71.
[7] Hammer, M., & Champy, J. (1993). Reengineering the Corporation－A Manifesto for Business Revolution. *Harper Business*, **8**, 156-158.
[8] Hunton, James E., Barbara Lippincott, & Jacqueline L. Reck. (2003). Enterprise resource planning systems: comparing firm performance of adopters and nonadopters. *International Journal of Accounting information systems*, **4**, 165-184.
[9] Kalakota, Ravi, & Marcia Robinson. (2001). e-business 2.0: Roadmap for Success, 243-265.
[10] Karsak, E. Ertugril, & C. Okan Ozogul. (2009). An integrated decision making approach for ERP system selection. *Expert Systems with Applications*, **36**, 660-667.
[11] Kremzar, M. H., & Wallace, T. F. (2001). *ERP: Making it happen: The implementer's guide to success with enterprise resource planning*. New York: Wiley.
[12] Langenwalter, G. A. (2000). *Enterprise Resources Planning and beyond: integrating your entire organization*, St. Lucie Press, Inc.
[13] Lall, V., & Teyarachakul, S. (2006). Enterprise resource planning (ERP) system selection: A data envelopment analysis (DEA) approach. *Journal of Computer Information Systems,* **47**(1), 123–127.
[14] Mraz, S.J. (2000). Keeping up with ERP. *Machine Design*, Jul 20, 56-60, Penton Publishing.
[15] Motwani, J., Mirchandani, D., Madan, M., & Gunasekaran, A. (2002). Successful implementation of ERP projects: Evidence from two case studies. *International Journal of Production Economics*, **75**(1–2), 83–96.
[16] Mile,M.B., and Huberman,K. (1994). Qualitative Data Analysis, pp.45-52.
[17] Norris, Grant, R. James, H. Kenneth, R.D. John. (2000). *E-Business and ERP: Transforming the Enterprise* (pp.86-102). New York: John Wiley & Sons Inc.
[18] Park, Carol, A. (2000). ERP: Tools, Techniques, and Applications for Integrating the Supply Chain, 56-78.
[19] Poston R, Grabski S. (2001). Financial impacts of enterprise resource planning implementations. *International Journal of Accounting information systems,* **2**, 274-94.
[20] Sen, C.G., H. Barach, S. Sen, H. Basligil. (2009). An integrated decision support system dealing with qualitative and quantitative objectives for enterprise software selection. *Expert System with Applications*, **36**, 5272-5283.
[21] Umble, Elisabeth J., Ronald R. Haft, M. Michael Umble. (2003). Enterprise resource planning: Implementation procedures and critical success factors. *European Journal of Operational Research*, **146**, 241-257.
[22] Wier, B., J. Hunton, H. R. Hassab Elnaby. (2007). Enterprise resource planning systems and non-financial performance incentives: The joint impact on corporate performance. *International Journal of Accounting information systems*, 8, 165-190.