

The Influence of Enterprise Resource Planning upon Organizational Performance: A Method of Meta-Analysis

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ABSTRACT : *This study aims to understand the effects of Enterprise Resource Planning on organizational performance in Taiwan-listed information electronics companies. This study is conducted on the basis of existing data collected by domestic and overseas scholars, and the Meta Analysis method is applied to this data. The finding of this study shows that implementing enterprise resource planning in Taiwan-listed information electronics companies has a significant positive effect on organizational performance.*

Keywords: *Resource Planning, Organizational Performance, Meta-Analysis*

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I. INTRODUCTION

Due to the recent industrial structural changes in Taiwan, the electronics industry is one of the fastest growing domestic industries. Under the challenges of adapting to a "fast" and "wide" industrial environment, the integrated information systems that are traditionally limited only to a factory or a company, such as CIM or MRP II, no longer meet industrial demands. As a result, the information systems with a higher level of integration, Enterprise Resource Planning (ERP) are born [1] .

As information technology advances, global management becomes the mainstream operation for enterprises. In this global competition game, enterprises must maintain the optimal allocation of managed resources to ensure survival and continual development. Enterprise Resource Planning (ERP) systems, which are becoming trendy in the industry, are powerful information management tools that provide assistance to achieve optimal resource management. The primary focus of ERP is the information integration of every aspect of an enterprise's primary functions. Therefore, adopting ERP affects a wide range of enterprise operations. The deciding factors contributing to the adoption of ERP must be more complex than that of other information systems [2] .

In this industrial environment that is drifting into global competition, ERP has become the best tool for adapting to this rapidly changing environment; in particular, of all the resource planning and Supply Chain Management (SCM) systems, ERP stands out as the central nervous system that provides information convergence, integration, and exchange, and it is also the backbone that supports e-commerce growth and development. In terms of the value chain of enterprise cooperation, ERP can provide integrated real-time information that is cross-company and cross-region, as well as optimal and dynamic resource allocation and usage, so as to achieve the goals of an enterprise's value chain integrated operation. The entire value chain system can thus respond quickly to customer needs and improve product or service performance levels [3] .

Therefore, this study applies Meta-Analysis as the research tool, and aims to understand the effects on organizational performance when adopting ERP in Taiwan-listed information electronics companies, which is also the main purpose of this study.

II. LITERATURE REVIEW

To gain a general understanding of literature review relevant to the topic of this study, a summary of such review is described as follows:

Enterprise Resource Planning (ERP)

In this study, the conceptual definition of enterprise resource planning is "an on-line transaction processing (OLTP) system, a ready-to-use software suite that supports most of the major operational functions in an enterprise, such as logistics, sales and financial management, and is capable of integrating the operating processes of an enterprise's finance, accounting, production, material management, quality management, sales and distribution, and human resources management functions to form an information sharing system that is

cross-sector and cross-region. That is, it is capable of integrating all information required by an enterprise, including the planning process, sales and marketing, and to help business managers make the best decisions." The above definition is derived from following literature.

Chang [4] pointed out that ERP is a new concept that combines technology and management, integrates various information within an enterprise's value chain, and streamlines the operation process.

Chen [5] indicated that ERP is essentially an on-line transaction processing (OLTP) system, and it differs from traditional information systems with its real-time and integration functions; its technological framework is aimed at providing a single database system and a universal application for all users in an enterprise organization. Thus, with the ERP system, all enterprise functions relevant to the production process, finance, sales and others are integrated to achieve the goal of providing real-time information and effective management.

Hammer [6] believed that an ERP system can integrate all information in an enterprise, including planning processes; sales and marketing, and help enterprise operators make the best decisions. An ERP system is a single software application that can integrate various departments and various functions within an enterprise. It can also be described as a family of software modules, sharing one database and functioning seamlessly together, to support the operating process of an enterprise.

The description in APICS [7] stated that an ERP system is an effective method for planning and controlling all resources required in accepting, manufacturing and closing customers' orders for the manufacturing, logistics and service industries. It is a ready-to-use software suite that supports most of the major operational functions in an enterprise, such as logistics, sales and financial management [8], and is capable of integrating the operating processes of an enterprise's finance, accounting, production, material management, quality management, sales and distribution, and human resources management functions to form an information sharing system that is cross-sector and cross-region.

Chuang et al [3] also pointed out that ERP is a new concept that integrates all, or part of, major operations in an enterprise. It is an enterprise-grade information tool that helps a business adapt to the accelerated path of operation, and, as the information cycle and management control cycle shorten, it enables the business to quickly turn around in a changing environment. In addition, as the adoption of ERP increases, the functionality of the software expands, and the significance of ERP also magnifies. Today, any integrated application software that contributes to the optimization of business resources is regarded as being within the broad category of ERP.

Organizational Performance

In this study, the conceptual definition of organizational performance is "the performance of an organization; a measurement of an organization's ability to achieve a stage of, or complete goals, in accordance with the organization's clear mission and policy, thus enabling its various businesses and departments to create the high value that fulfills the organizational mission and vision within a certain time frame." The above definition is derived from following literature.

Venkatraman & Ramanujam [9] defined organizational performance in two different categories: in the narrow sense, organizational performance refers to financial indicators that meet the company goals; while, in the broad sense, organizational performance refers to company performance, including financial (revenues, ROA and others) and operational (product quality, market shares and others) indicators.

Hsin [10] pointed out that organizational performance is the performance of an organization, which also shows the relationship between the actual results and original targets. Organizational performance is a standard for measuring results: if the subject of measurement is an individual, it is called job performance; if the subject is an organization, it is called organizational performance.

Ling and Hung [11] believed that organizational performance refers to the results achieved by various businesses and departments of the organization within a certain time frame in order to attain stage, or overall, goals.

Yei [12] pointed out that the existence of an organizational mission is the basis of organization existence. If an organization cannot clearly define its mission, it cannot clarify its business direction and goals, nor can it create the high value required to meet its organizational mission and vision.

Hsieh [13] proposed that the BSC system is a performance management tool that uses strategic achievement as the goal, which can then be translated into actions used to guide an organization in achieving its goals, and can be used as organizational performance indicators.

Literature Review Relating to Enterprise Resource Planning and Organizational Performance

An ERP system is real-time information software that links a company's internal with external, and its primary focus is in integration. Hammer & Champy [14] argued that modern IT can quickly redesign business processes and complete business process re-engineering (BPR) to make businesses more efficient.

The research of Chang [4] showed that prospector and analyzer strategies are far better than defender strategies when measuring the conditions conducive for implementing ERP and in the resulting performance of an organization. In addition, the conducive conditions for implementing ERP are highly correlated with organizational performance. For a company using analyzer strategies, the more favorable the conditions for implementing ERP are, the more favorable its information technology performance and financial performance will be.

Tsai [15] argued that the results of objective data analyses show that, after introducing an ERP system, an enterprise's company scale and its sales income are positively correlated.

Lee [16] indicated that the positive effects of the three aspects of an enterprise: organization, management and information technology, on the performance of ERP application and introduction, are positive and significant. In addition, this model shows that ERP performance affects the management aspect more than the functioning aspect. Additionally, his research finds that the impact of the management aspect is the most significant, with regards to organizational performance, which indicates that an enterprise must pay more attention to issues relating to the management aspect, so as to enhance the performance brought on by the application of ERP.

Cheng [17] believed that, after the introduction of an ERP system, many businesses will considerably shorten the time required to compile financial statements.

Lin [18] also believed that if an ERP system is introduced successfully into a company, it can be a great help to the business management of that company. It can further help raise revenue and increase profitability. After exploring the case study of his research, the results show that, after introducing an ERP system, the company's operating processes indeed become smoother, leading to a positive cycle with the company's revenue increasing annually, along with its profitability.

Lin [19] pointed out that the software system and hardware equipment of an ERP system, and their output of information, are both helpful in promoting individual and organizational efficacy.

The research of Wu [20] showed that the performance of an ERP system varies in different departments, and that many of the performance measurement indicators are positive.

III. RESEARCH METHOD

Based on the above research motives, purpose and literature review, this study deduced research hypotheses, and constructed a conceptual research framework, as shown in Figure 3.1.

Research Framework

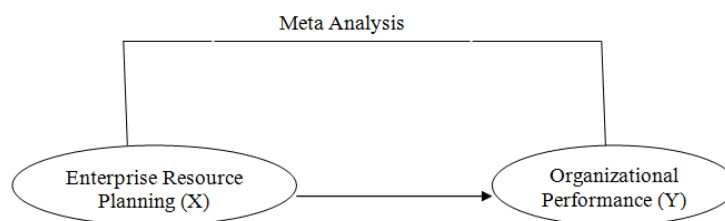


Figure 3.1 The Conceptual Framework of this Study

Data Collections and Methods

Data collected on organizational performance in this study is from the database of the Taiwan Economic Journal (TEJ) and questionnaire. Meta-analysis is the research model, and Stata is the software used in this study. This study hypothesized that the estimated parameter is consistent with the Normal Distribution (N.D.), when the heterogeneity is greater; adopting Random Effects would be a better choice than Fixed Effects. Thus, this study applied Random Effects for comparing a variety of effects [21].

The Theoretic Basis for Meta-Analysis [22]

- The Highlight of DerSimonian & Laird Method (Random effect method)
- ◆ For binary or continuous outcomes
- ◆ Effect size q_i for study i could be $\ln(\text{OR}), \ln(\text{RR}), \text{RD}$, difference in means or standardized mean difference.
- ◆ Note that the effect sizes for OR and RR are logged.
- ◆ Assumption that there is a single true answer that all studies are trying to estimate is relaxed.

- ◆ Now assume that each study has a different true answer that they are trying to estimate.
- ◆ Assume true effect sizes θ_i have normal distribution with mean θ and variance τ^2 .
- ◆ τ^2 is the between-study variance.
- ◆ Between study variance:

$$\tau^2 = \frac{Q - (k - 1)}{\sum_i w_i - \left[\frac{\sum_i w_i^2}{\sum_i w_i} \right]}$$

Where:

w_i are weights from the fixed effect inverse-variance method

Q is the heterogeneity test statistic form before (either form inverse-variance method or Mantel-Haenszel method)

K is the number of studies, and

τ^2 is set to zero if $Q < k - 1$

- ◆ Random effect pooled estimate is weighted average:

$$\theta_{DL} = \frac{\sum_i w'_i \theta_i}{\sum_i w'_i}$$

- ◆ Weights used for the pooled estimate are similar to the inverse-variance, but now incorporate a component for between-study variation:

$$w'_i = \frac{1}{SE(\theta_i)^2 + \tau^2}$$

- ◆ When there is little heterogeneity, so Q is smaller than k-1, $\tau^2 = 0$ and the weights are the same as the inverse-variance method.

- ◆ When $\tau^2 > 0$ the weights are smaller and more similar to each other than in a fixed effect model.

- ◆ Because the weights are smaller, the sum of weights will be smaller, and so the SE will be bigger, CIs wider, and p-values less significant.

- ◆ Small studies will have relatively greater influence.

- ◆ Advantages:

- ✓ As widely applicable as the inverse-variance fixed effect model
- ✓ Incorporates heterogeneity into the model

- Confidence interval for pooled estimate

A 95% CI for the pooled estimate θ is:

$$\theta - (1.96 * SE(\theta)) \text{ to } \theta + (1.96 * SE(\theta))$$

For ratios, θ is the log-transformed estimate.

- Test for overall effect

Overall significance test for whether the pooled estimate is significantly different from zero (no effect):

$$z = \frac{\theta}{SE(\theta)}$$

Look up z in tables of the normal distribution to get the p-value.

For ratios, θ is the log-transformed estimate.

- Test for heterogeneity

- ◆ Look up Q in tables of the chi-squared distribution on k-1 degrees of freedom. The null hypothesis is that the true effect size is the same for all studies.

- ◆ A statistically significant result means that there is strong evidence against there being one common effect size, so we take it that there is heterogeneity.

- Getting Data into Stata

- ◆ Easier to enter into Excel then cut & paste into Stata's data editor
- ◆ Ensure each numeric column contains only numbers

- ◆ Leave cells empty if data missing
- ◆ One row per study

IV. RESEARCH RESULTS AND ANALYSIS

The results of using Meta- Analysis to perform Random Effects analysis are shown in Table 1 below:

Table1: Random Effects

Study	WMD (95% CI)	% Weight
Hammer & Champy [14]	5.13 (4.62, 5.63)	11.81
Chang [4]	5.43 (5.03, 5.83)	12.23
Tsai [15]	5.83 (5.43, 6.22)	13.84
Lee [16]	5.52 (5.12, 5.92)	12.37
Cheng [17]	5.63 (5.32, 5.93)	12.42
Lin [18]	5.63 (5.23, 6.03)	12.42
Lin [19]	5.67 (5.42, 5.92)	12.51
Wu [20]	5.58 (5.14, 6.02)	12.40
Overall (I-squared=55.5%, p=0.001)	5.55 (5.16, 5.94)	100.00
NOTE: Weights are from random effects analysis		
Scale Range	0 1 2 3 4 5 6 7	

As indicated in the report above, where "Overall" showed I-squared = 55.5 and p-value = 0.001, we learned that the independent variables of this research model have significant positive effects on dependent variables.

V. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The above description shows the findings of this study concerning the effects on organizational performance of adopting ERP by Taiwan-listed information electronics companies. These findings are identical to the research results of Hammer & Champy [14] , Chang [4] , Tsai [15] , Lee [16] , Cheng [17] , Lin [18] , Lin [19] , and Wu [20] , except that the weights are different.

Research Contribution of this Study

In reviewing relevant existing literature, the research found that a majority of the papers applied regression analysis for exploratory research, and rarely applied Meta-Analysis to conduct the research. Therefore, choosing Meta-Analysis as the research method for this study is innovative.

Additionally, the research results of this study can be offered to management personnel of Taiwan-listed information electronics companies as a reference for maintaining sustainable operations. Therefore, the research results of this study have a very practical reference value.

Research Limitation and Recommendations

As mentioned above, the primary research targets of this study are Taiwan-listed information electronics companies. This study applied Meta-Analysis on relevant literature, domestic and overseas, to understand the effects on organizational performance when these companies adopt enterprise resource planning. This study recommends that subsequent researchers may consider research on other industries, or various scales of companies of the same industry, or applying other research methodologies, such as using Confirmatory Factor Analysis (CFA) on different industries, or comparing the goodness-of-fit differences of various industries within the same model.

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