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An ERP System Life Cycle-Wide Management and Support Framework for Small- and Medium-Sized Companies

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Abstract:

Currently, the companies that have introduced the ERP system in Taiwan are mostly large enterprises. Due to the high cost of introduction and uncertain performance, however, ordinary small- and medium-sized enterprises can hardly afford the system. Thus, not only would a reference model for ERP life cycle-wide management support and assist large enterprises in evaluating and renewing the system, but it would also offer small- and medium-sized enterprises a set of procedures to successfully introduce the ERP system. The objective of this research is to explore the life cycle-wide management and support activities of an ERP system in order to establish a managerial model which can be used as a guideline for managers in dealing with their critical managerial activities. This study applied both the results from the literature review and Delphi study on the basis of Gowin's Vee Approach. Through literature review, this research initially determined the life cycle-wide activities of the ERP system and then used the Grounded Theory to develop a prototype of the reference model for ERP life cycle-wide management and support. Subsequently, this study used the Delphi Method to collect the opinions of field experts. After analyzing and organizing the results, comparison and amendments were made to propose a final set of reference models for ERP life cycle-wide management and support. From the perspective of academic research, the authors believe that this study contributes to the development of a managerial model and provides prospective researchers with future directions in this subject area. As for the business sector, this managerial model can assist large enterprises through a better approach in management and support of the current ERP system, while small- and medium-sized enterprises are provided with a set of concrete steps to facilitate the successful introduction of the ERP system.

Keywords: ERP, Gowin's Vee model, Grounded Theory, Delphi method, System development life cycle, IEEE/EIA 12207 framework

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I. INTRODUCTION

According to the study of Gartner Group [2003], the global market size of Enterprise Resource Planning (ERP) system in 2004 was U.S. $30.2 billion, which is a 2.5 percent increase in growth from 2003. It is also expected that the growth of the global ERP market from 2006 to 2008 will be at 5.7 percent, 7 percent, and 8.5 percent respectively. Among global market participants, one of the regions that has fastest growth in this area is the Asia Pacific market. The main reason for the emergence of the Asian market is that China joined the game and is currently in the introduction stage of ERP system. In spite of its earlier primitive development, the manufacturing and trading industries in China are becoming the fastest and easiest business environments for ERP development. Since China now plays a key role in the manufacturing area, an even bigger market for ERP development can be expected from China in the next decade.

It is worth noting that the percentage of those obtaining the license for ERP applications in proportion to the entire ERP market has dropped from 22.3 percent in 2002 to 12.5 percent in 2005. In other words, the statistical facts indicate that the entire global ERP market size is surprisingly shrinking. According to "Global Information Service Market Size Analysis," a research report issued by the Market Intelligence Center (MIC) of the Institute for Information Industry, with the saturation of the large enterprise market and the higher maturity of the ERP technique, intensive market competition has driven licensing prices downward [Chang, et al. 2003]. Furthermore, since the era of high growth in the Euro-American market has temporarily leveled off, the market has begun to shrink. Nevertheless, the Gartner Group predicts that the entire ERP market shall rejuvenate due to a new wave of ERP replacement or renewal that started in 2006.

Looking at the information application market in Taiwan, significant growth has been observed since 1997, which indicates that the application software market in Taiwan shares a similar pace with the international market. According to MIC's research, the market size of information service for Taiwan in 2004 was approximately NT $142.9 billion, and this shall reach NT $150 billion in 2005, a 5 percent growth estimate. In contrast to the declining global environment, Taiwanese enterprises are still actively investing in information technology. Generally speaking, although the development of ERP in Taiwan has not yet reached a maturity stage like that in the Euro-American market, it has reached a certain level of popularity.

It may be said that the ERP industry in Taiwan is approaching its maturity stage and is growing into an environment with fierce competition. With so many ERP system providers or application software consulting companies, each of them has implemented their own unique model or framework for managing the life cycle of an ERP system with some similar and different practices. However, since there are so many different models and/or approaches, selecting the most adequate system is important. In other words, how does one manage and support ERP implementation with the easiest operation? The fact is, every vendor or consulting company has a unique viewpoint about the kind of management and support activities that should be under the life cycle of an ERP system. The life cycle of the ERP system of a certain application vendor may be adequate only to that ERP product. In addition, the life cycle-wide of an ERP system management and support proposed by a different consulting company may be different as well. From the viewpoint of the system life cycle of an industry, the ERP market is about to enter a new wave of replacement, which means that companies may want to replace existing ERP systems with new ones. At present, the activities of the entire ERP project may change accordingly and therefore may not fit well with the new system. Under what circumstances would the need of an appropriated management and support pattern for companies be applicable will become an important question for the future.

The ERP system life cycle-wide management and its support are actually an ongoing concern. In fact, the pre-implementation, implementation, and post-implementation stages continue throughout the lifetime of an ERP system as it evolves with the organization [Dailey 1998; Chang and Gable 2002; Aloini 2007; Wu and Wang 2007]. Unlike the traditional view of an operational Information System (IS) that describes a system life cycle in terms of development, implementation, and maintenance, the ERP implementation cycle involves the process of iterations. Following the initial implementation, there are subsequent revisions, re-implementations, and upgrades that transcend what is normally regarded as system maintenance. However, can IT professionals go beyond the content of prior studies and treat the life cycle of an ERP system from another perspective? As the number of organizations implementing ERP increases, the ERP applications within organizations proliferate [Bancroft 1998; Davenport 2000; Chang and Gable 2002; Cotteleer and Bendoly 2005; Wu and Wang 2007]. To this end, an appropriate reference model for ERP life cycle-wide management and support is required so that such model may be used to monitor

performance during the adoption stage and in other various stages of life cycle during the ERP system implementation.

The following sections begin with a literature review and are followed by a Delphi study on the basis of Gowin's Vee model. From the reviewed literature, the inference method of the Grounded Theory is chosen as a vehicle to develop a prototype of the reference model that will be suitable for the management and support of enterprises in the ERP life cycle. To refine the prototype model, two rounds of Delphi study with the selected participants were conducted; information and data obtained from the Delphi studies were then analyzed and organized to develop the reference model for management and support in the ERP life cycle. Finally, a comparison and amendment between the two models were made to propose a final set of reference models for ERP life cycle-wide management and support.

II. THEORETICAL BACKGROUND AND DISCUSSION

The Adoption of Enterprise Resource Planning Systems

Organizations worldwide, whether public or private, are moving away from the traditional in-house development of Information Systems (IS) and are instead implementing Enterprise Resource Planning (ERP) systems and other related packaged software [IDC 2000]. ERP has been referred to as a business operational system that enables better resource planning and improved delivery of value-added products and services to customers. In recent years, ERP systems have begun to revolutionize business processes and functions. They automate core corporate activities such as manufacturing and the management of finances, human resources, and the supply chain. This has eliminated complex, expensive links between systems and business functions that had been previously performed across legacy systems [Gable et al. 1998; Bingi et al. 1999; Klaus et al. 2000; Kumark and Hillegersberger 2000; Marbert et al. 2000; Hong and Kim 2002; Tarn et al. 2002; Sarker and Lee 2003; Cotteleer and Bendoly 2005; Aloini et al. 2007; Wu and Wang 2007].

The functions of an ERP include integrating the internal or external resources of an enterprise, allowing managers to control the efficiency and operational situation of the entire enterprise, and improving the enterprise's overall competitive capability. The American Product Inventory Control Society (APICS) defines ERP as "a system (with) a financial accounting oriented information system. Its primary functions include effectively integrating and planning resources required for satisfying customers' orders (such as resources required for procurement, production, and distribution logistics), increasing overall operational performance and reducing cost." Consequently, an ERP system integrates all information within an enterprise, consolidates cross-department functions and regional business activities, realizes information sharing via the Internet, and supports the applications of other related modules. The operational flows of an enterprise are therefore integrated, and optimal benefits are achieved. Davenport [1998, 2000] believed that an ERP system facilitates linking to enterprise internal information systems and integrates operational information from all departments. Such centralized databases and applications are then used for the enterprise's decision-making support. In the simplest way, the ERP system is an integrated system of application software that provides solutions for an enterprise to allocate its overall resources and real-time information about operations and management in order as a means to increase enterprise competitiveness.

ERP systems have proven to be a useful solution to integrate business processes and resources with an enterprise's operational and management strategies [Davenport 1998; Klaus et al. 2000; Markus et al. 2000; Sarker and Lee 2003; Amoako-Gyampah and Salam 2004; Gefen and Ragowsky 2005; Holsapple and Sena 2005]. Several potential tangible and intangible benefits of applying the ERP technology to various businesses include the following: (1) improving organizational performance; (2) understanding a range of functionalities not catered to in the existing system; (3) increasing returns from the implemented ERP systems; (4) streamlining the organization's internal processes; (5) lowering costs for developing an ERP that more accurately reflects business needs; (6) improving capability to react to a changing environment; and (7) improving customer satisfaction related to services rendered or products manufactured [Li 1999; Davenport 2000; Irani and Love 2001; Chang and Gable 2002; Rajagopal 2002; Gattiker and Goodhue 2005; Ranganathan and Brown 2006]. Cotteleer and Bendoly [2005] researched the influence of enterprise systems' implementation on operational performance. They found that ERP implementations gave rise to an ongoing trend of performance improvement, which is in contrast to a stable performance trend prior to go live.

Although ERP promises better resource planning and execution together with improved product and service delivery, most organizations have not fully realized the expected benefits from these systems. Warnings raised from prior IS literature have become widespread [e.g. Davenport 1998; BCG 2000; Soh et al. 2000; Chang and Gable 2002; Scott and Vessey 2002; Gattiker and Goodhue 2005; and Wei 2007]. Such warnings include the following: (1) more than 40 percent of large software projects ended unsuccessfully; (2) 90 percent of ERP implementations ended up late and/or over budget; (3) continuing shortages and the concomitant turnover of ERP staffs contributed to high ERP costs; (4) the growth in ERP consulting services has led to a proliferation of methods, techniques, and

tools which cause implementation difficulties; and (5) 67 percent of enterprise application initiatives could be considered either as counterproductive or unsuccessful. These difficulties with the packaged software implementation suggest that many organizations underestimate the issues and problems which are often encountered throughout the ERP life cycle.

The adoption of ERP has been prevalent among enterprises since 1997 when SAP set up its branch office in Taiwan. Following the entry of Taiwan in the World Trade Organization (WTO), cross-strait interaction became much closer. The capabilities of information sharing and quick transmission became a requirement in business operations wherever the head office is established. Moreover, many large-sized enterprises in Taiwan pioneered the adoption of ERP systems as a way to effectively handle transactions and lower costs of performing repeated work inside the company. According to the conference on "the new opportunity of national information service development in the 21st century" sponsored by MIC, the ERP turnover amounted to TWD 18.09 billion, and the resulting compound growth rate arrived at 30 percent, signifying that the market share is growing year by year.

The reasons for this trend resulted primarily from the proportion of ERP adoption in Taiwan's small- and medium-sized enterprises (SMEs), which gradually and steadily increased. Many SMEs may be able to learn faster and more effectively than their fewer, larger counterparts. Meanwhile, more and more ERP providers value the potential of the SME market, and thus increased their focus on appropriate promotional strategies and better-fit of functional alternatives. Second, many leading system providers around the world have suggested cooperating with manufacturers in Taiwan to install ERP in order to help increase the production efficiency of a global supply chain. Third, the transfer of the production of Taiwan's SMEs to Mainland China urgently needs the application of ERP to assist in an effective cross-strait business management. Though the ERP market has slowly increased over the years, the adoption of ERP for SMEs still appears to be sluggish. According to Hung and Liang [2001], SMEs in Taiwan generally sit back and watch because ERP adoption has to match with business process reengineering. It also incurs substantial expenses with unknown effects. Hence, the aforementioned study concluded that most enterprises still hesitate to move forward. This fact strongly suggests that management and support activities after the introduction of the ERP system should be valued. Furthermore, these aforementioned activities are exactly what enterprises often ignore the most.

System Development Life Cycle Theory

Before the 1970s, the traditional methods of software development were not systematic; people simply broke down the functions of software, and no clear or specific development tools were utilized to perform the tasks. Generally speaking, a word processor was employed to generate textual description-based system specification and file format descriptions, which were developed into software. Instead of focusing on the preliminary analysis stage, this methodology placed more emphasis on program writing. Although such methods might complete system development tasks faster, it often generates disappointing results or leads to the so-called "software crisis" involving unmatched functions, maintenance difficulties, increased costs, reduced productivity, and lower user satisfaction [Fichman and Kemerer 1992].

After the 1970s, the production cycle model that was popular in the hardware industry was adopted and quickly became the mainstream development model for the software industry. The so-called software life cycle was used to control/supervise the entire procedure of a system from production to abandonment stages. According to Palvia and Nosek [1993], the software life cycle can be categorized as a collection of such phases: system analysis, system design, system development, and system operation. End information in every stage of a life cycle would be the input information for the next immediate stage. Information from stage to stage can be repeated, back fed, and adjusted. However, if the process is already in the last stage, going back to the first stage for adjustment would be very difficult [Plyler and Kim 1993]. Therefore, in every stage of the development life cycle, appropriate methods and tools should be used to prevent major errors and ensure the success of software development.

In 1995, the ISO/IEC 12207 model was announced by the International Organization for Standardization and International Electrotechnical Commission (ISO/IEC) to regulate the procedure of system life cycle. In 1998, IEEE and EIA jointly developed the IEEE/EIA 12207 model to serve as the standard in the foundation for software development, management, and support activities. The IEEE/EIA 12207 development, management, and support model originated from the ISO/IEC 12207 model. Its purpose was to consolidate all standards of software engineering in the past and provide a universal backbone structure for the development, management, and support of a software system.

The content of IEEE/EIA 12207 development, management, and support includes the primary life cycle, supporting procedure, organizational procedure, and attached customization procedure. The primary life cycle includes acquisition, supply, development, operation, and maintenance procedures. Supportive life cycle procedures include the documentation activity, configuration management, quality assurance, verification, validation, joint review, audit,

and problem resolution areas. Organizational life cycle includes management, infrastructure, improvement, and training. There are many activities under each procedure and many tasks under each activity. IEEE/EIA 12207 has defined a total of 17 procedures, 74 activities, 231 tasks, and 84 documents. Figure 1 shows the structure of IEEE/EIA 12207 development, management, and support model [IEEE and EIA 1998].

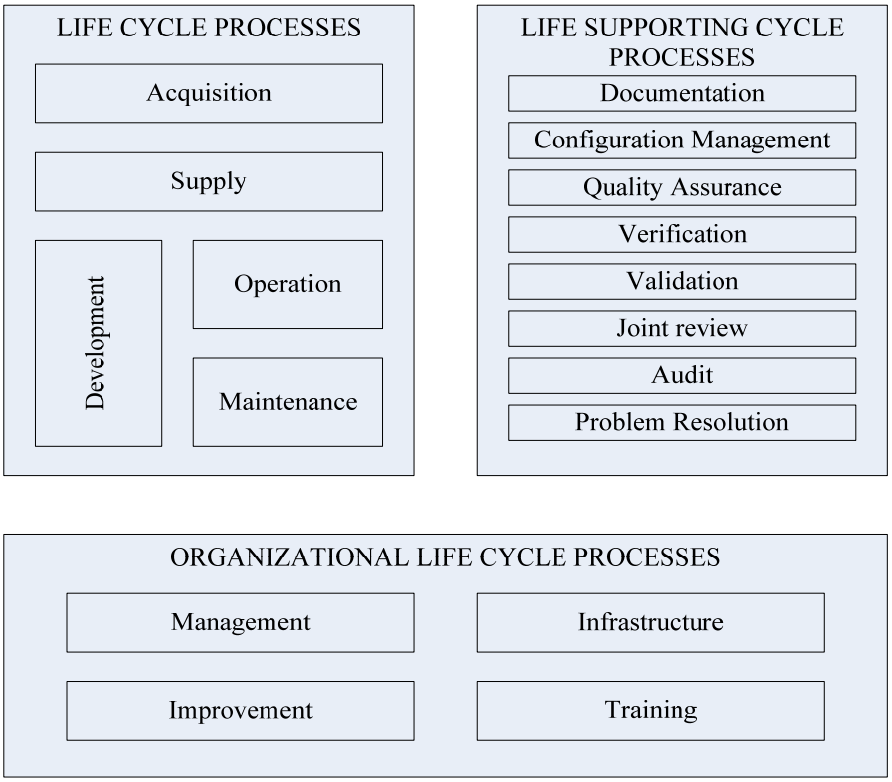

Figure 1. IEEE/EIA 12207 Development, Management, and Support Model

After the introduction phase, the original cooperate control system may be utilized to proceed with the management and support of the ERP system. Based on prior literature related to software life cycle and ERP system life cycle [e.g. Bancroft et al. 1996; Gable 1998; Markus and Tanis 1999; Ross 2000; Ross and Vitale 2000; Parr and Shanks 2000; Rajagopal 2002; Aloini 2007] and the other methods proposed by the vendors (e.g., SAP – ASAP, Oracle – AIM, IBM – Method Blue), this research summarized that an ERP system life cycle should include the following five phases:

1. *Evaluation phase* — At this phase, the enterprise must determine if the new ERP system is conducive and beneficial to the enterprise with regard to the challenges it encountered and overall strategies it implemented. This phase includes the identification of the requirement of an ERP system, the objective for acquiring it, the benefits of using it, and the impact of adopting it in the enterprise.
2. *Acquisition phase* — This phase includes selecting the products that will be most suitable for the enterprise to diminish the requirement of customization. In this phase, the consulting company would also provide assistance to the enterprise with regard to the management of the other following phases — particularly the next phase, which is formal introduction. Other factors such as functional consideration, price, training, and maintenance service are analyzed and defined in the contract. At this phase, the investment return rate of the ERP system should also be valued.
3. *Formal introduction* — This phase includes customization or setting up of the parameters and modules which would fulfill the requirements of the enterprise. It is usually necessary to seek the assistance of a consulting company that would offer system initiation/introduction methods and/or theories, operation, and training. However, it should be noted that the aspect of training is actually involved in each phase. Furthermore, the investment is particularly critical at this phase.
4. *Operation and maintenance* — At this phase, the functional, usable aspect, and organizational propriety are of particular importance. Once the system is implemented, the issue of maintenance would be required because any abnormal operation should be modified to match the enterprise's optimization requirements. This phase would further proceed with ordinary modification.
5. *Expansion* — Since the enterprise may have different businesses, the additional functions must be integrated with the ERP system in order to accomplish maximum corporate benefits. This part includes the upgrading of the

ERP system (which is related to the programming of the system such as the planning of advanced scheduling, data storage, and enterprise smart system), and the integration of related systems (referring to the integration of the ERP system including the management of the supply chain, e-commerce, etc.)

Based on the previous discussion, it is not surprising to note that each scholar has a differing opinion regarding the phases of the ERP life cycle. However, they all pay considerable attention to the processes of evaluation and constant improvement, including the maintenance of the system and the addition of necessary modules after the implementation stage. The enterprise should carefully consider managerial activities after the introduction of the ERP system. After all, the phases of system maintenance and module addition will affect the operation of the enterprise for at least 5 to 10 years. In other words, during the whole life cycle of the system, the longest time span would be needed for the phase after the ERP introduction instead of before. Thus, the enterprise should meticulously consider related management and support issues after the introduction of a particular technology.

As a point of comparison with previous standards, IEEE/EIA 12207 defines the major activities and deliveries on the entity level which can provide benefits of repeatability and organization maturity [Lee et al. 2002]. On the other hand, it presents a reference guide for processes and outputs of software development. Due to the above reasons, ERP systems are software packages in fundamental nature. In this study, we employed IEEE/EIA 12207 which is published by an international institution as a framework to construct the ERP system life cycle.

III. RESEARCH METHOD AND DESIGN

Research strategy

Gowin's Vee [Noval and Gowin 1984] is a logical application tool with steps that users can easily follow. Gowin's Vee is a v-shaped structure model that was originally used for education and research. It includes the conceptual side (think) and methodological side (do). The advantage of this chart (see Figure 2) is that it reveals how to "think" and "do" simultaneously. It can be used as a tool for exploring a learner's awareness about the structure of knowledge, or as a tool to aid in learning. Through the close connection and interaction between new and old knowledge, a learner may obtain sustainable learning capabilities with new experiences. Gowin's Vee model is therefore used to reinforce the purpose of this research, and to ensure that the research direction does not deviate from the basic research background and motivation. The following discussion can be used to briefly explain the main directions proposed in this study.

- *Focus question and research purpose* — This research regards the focus questions to be the background and motivation in pursuing this study, and Gowin's Vee model is used to help define the research purpose.
- *Theory side (literature)* — The crux of every successful research is to have sufficient theories that are related to the topic of the research for further recognition and exploration. This research uses Gowin's Vee approach to help establish a model that converts the original life cycle concept to a final major concept in accordance with prior literature and theories — specifically, the Grounded Theory analysis. By using Gowin's Vee approach, this research may increase the efficiency and quality in the literature study, and help readers understand how the proposed model was established.
- *Method side in practice* — The method adopted in this research was based on the Delphi method developed by the Rand Corporation in the 1950s [Dalkey and Helmer 1963]. This method uses an iterative feedback technique with a group of experts and is particularly useful for aggregating the judgments from several dispersed individuals [Bass 1983]. Furthermore, it is a technique for the systematic solicitation and collation of judgments on a particular topic through a set of carefully designed sequential questionnaires, interspersed with summarized information and feedback of opinions derived from earlier responses [Delbecq et al. 1986].
- *Interaction and feedback* — The model derived from the theory side (in the literature) is compared with the method side (in practice). This is shown in Figure 2. The result is compared and modified in order to achieve the proposed objective of this research and to find out relevant questions for future research directions.

The Grounded Theory

This research attempted to establish the suggested reference model after the literature review. Since this procedure involves activity analysis of the ERP life cycle, an appropriate qualitative method is therefore required. The Grounded Theory is an important method of performing qualitative research because its strengths include reorganization and summary of complicated information, recognition of the context of activity, and consequently, the construction of the management model. Thus, the Grounded Theory was adopted in this research. Strauss and Corbin [1990] found that the Grounded Theory systematically gathers information for further analysis, and then explores and develops temporarily verified theory. The Grounded Theory primarily uses the induction method for analyzing and reorganizing the research subject. Before a research begins, no related research hypothesis is established. The author summarizes directly from the original information and obtains various viewpoints and

concepts. These concepts are then converted into theories. In this study, the relationships between related concepts were not clearly defined; therefore, a theory is established in a bottom-up fashion. The concepts of related phenomena are searched and revealed from the foundation of information, and then a theory is established after the various relationships between concepts are investigated. Hammersley [1989] pointed out that the Grounded Theory follows scientific principles of comparison (e.g., a procedure in which induction and deduction are used simultaneously), verifies hypotheses, and establishes the theory. Therefore, Hammersley supports that the Grounded Theory is one of the most scientific methods available for conducting a qualitative research.

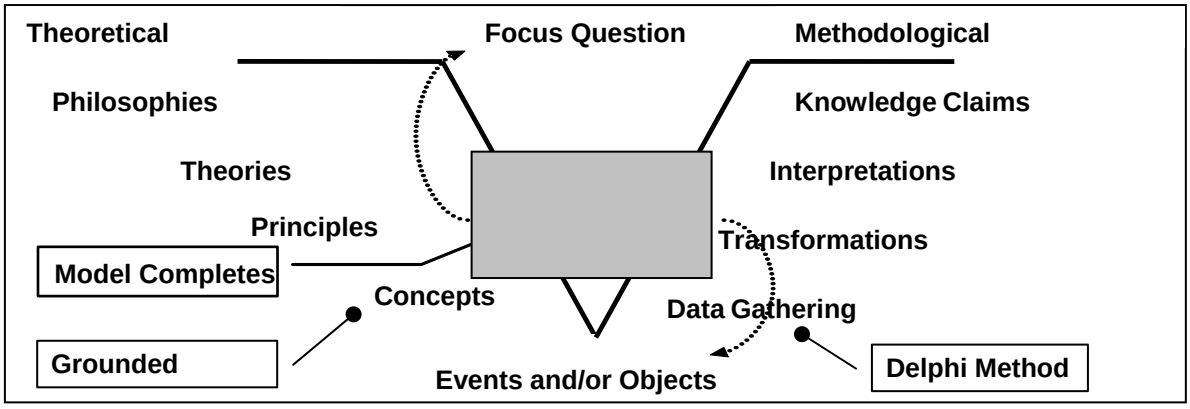

Figure 2. The Research Strategy

Delphi Study

During the past 30 years, Information Technology/Information Systems (IT/IS) has played an influential role in organizations. The rapidly changing role of information systems demands an ongoing assessment of major issues in the IS field. The IS literature in the last 20 years contains several excellent studies of relative importance to IS issues [e.g., Deans et al. 1991; Watson and Brancheau 1991; Watson et al. 1997]. Eight of these aforementioned important studies used the Delphi method to survey the perceptions of IS executives [i.e., Dickson and Nechis 1984; Brancheau and Wetherbe 1987; Watson 1989; Niederman et al. 1991; Dexter et al. 1993; Pervan 1993; Brancheau et al. 1996; Dekleve and Zupancic 1996]. Similarities among these major IS studies include the following items: (1) a sample list of issues was provided; (2) a heterogeneous respondent group was surveyed; (3) three to four consensus rounds were applied; (4) a 10-point item scale was employed; (5) a reasonable consensus was achieved; and (6) a final list of 20 to 30 issues was summarized. Watson and Brancheau [1991] recommended that the use of the Delphi method is appropriate for comparing and contrasting findings across similar studies, and by doing so, it can contribute to a cumulative IS management discipline.

IV. PROTOTYPE OF THE ERP LIFE CYCLE-WIDE MANAGEMENT AND SUPPORT REFERENCE MODEL

References

The main asset of the Grounded Theory is data. That is, any subject or detail of concern investigated by a researcher can be regarded as information whether or not it is generated or obtained from an interview, an observation, or anything that can assist the researcher to create the original constructs to establish theories. Even data collected from informal interviews, lectures, seminars, expert groups, news, and magazines, TV shows, and casual dialogues can be regarded as information. For the researchers, anything that is related to the subject or detail of concern can be treated as information, even if it is merely a good idea [Glaser 1998]. After the long data collection process, we decided to conduct the literature review based on research made by Hsu [1999], Cerullo et al. [2000], Fisher [2000], Tzeng [2000], Aladwani [2001], Mabert et al. [2001], Weston [2001], Nah et al. [2001], Hong et al. [2002], Ribbers et al. [2002], Motwani et al. [2002], Sarker et al. [2003], Mandal et al., [2003], Kumar et al. [2003], Gattiker et al. [2004], Chi et al. [2004], Chang et al. [2004], Lanham [2004], Wang et al. [2004], Yus uf et al. [2004], Yeh [2005], Chang [2005], Hwang et al. [2004], and Liu [2005].

Operational Process of the Grounded Theory

Open coding

This research initially proceeded with the coding of the content in the literature. Since the objectives of this research included identifying the critical managerial activities, any article containing paragraphs related to management or those pointing out successful managerial activities were selected and included. Furthermore, these paragraphs were

underlined and encoded. By following this procedure, the research discovered 356 conceptual results in total, which included 277 from English literature and 97 from Chinese literature. Based on these conceptual results, the researcher established 52 critical managerial control activities.

Axial coding

In order to establish different categories, this study initially analyzed 52 critical managerial control activities. The category was established based on those managerial control activities with mutual characteristics. As mentioned in the previous literature review section, the study adopted the life cycle of the software IEEE/EIA 12207 framework to perform the categorization. However, IEEE/EIA 12207 was originally developed for software development and/or design, and the processes of introducing the ERP system and software development are actually different. However, it is good to note that their basic properties are essentially the same. In order to adjust to the content of this study, several modifications were made. Thus, this research used the framework related to IEEE/EIA12207 which was the naming for axial coding based on three main life cycles: (1) primary, (2) supporting, and (3) organizational.

The primary life cycle process is the part that focused mainly on the life cycle of the ERP system. Its definition was narrower and focused on the life cycle of the ERP system, and was similar to the previous traditional software life cycle. On the other hand, the supporting life cycle process is the point where the main operation throughout the whole primary life cycle occurs. For each operation of the primary life cycle, this cycle functioned as the supporting role. In brief, the operations which were not considered as primary and organizational life cycles can be treated as the operations that support the life cycle. Finally, the organizational life cycle process is comprised of the necessary activities of the organization when proceeded with each operation of the primary life cycle. These activities were associated with the whole organization.

This research found that the categorization process of the supporting life cycle was the most difficult to establish. Thus, this research initially proceeded with the categorization of the primary life cycle and organizational life cycle. The operations that could not be categorized into either of the two were regarded as part of the supporting life cycle. The basis of the categorization of axial coding is as follows: (1) the activities related to the ERP system were considered a part of the primary life cycle; (2) the activities related to the whole organization were regarded as a part of the organizational life cycle; and (3) the activities that could not be categorized in the above-mentioned two processes were considered a part of the supporting life cycle. The axial coding process is provided in Table 1.

Selecting and coding

Through application of the open coding process, this study proceeded with information analysis, checking, comparison, and exploration of managerial control literature, with which it established 52 managerial control activities. The researcher further used the axial coding process to identify the primary, supporting, and organizational dimensions. These 52 managerial control activities, by nature, could be involved in the domain of all three axial codings performed in the previous subsection. The principles of the coding selection were based upon the definitions of the results obtained from the previous axial coding process. The conditions of coding are as follows: (1) the parts which were the same as or similar to the activities of the ERP introduction theories proposed by each company were considered to be the primary life cycle; (2) the managerial activities which were cross-phased by nature, involved the whole organization, or existed regardless of the introduction of ERP would be considered as a part of the organizational life cycle; and (3) the activities which could not be categorized into any of the two steps were considered to be the supporting life cycle.

Establishment of the Prototype Reference Model

Primary life cycle

As for the primary life cycle, this research divided it into five phases: acquisition, supply, development, launch, and maintenance. Regardless of the ERP system, these five phases always exist. It is important to note that each managerial phase works individually and hence will not affect each other.

In the acquisition phase, the main activity consists of the selection of the ERP software. Managerial personnel should pay close attention to the flexibility of the scale of software and the issue of prospective expansion. In addition, they should take the factors of executive efficiency and system integration into consideration. This consideration is also relevant to the factors affecting the operational system. As always, operational convenience is also a main consideration. Some companies might use more than two sets of ERP systems which are inconvenient, and the information could potentially not be delivered smoothly. In addition, the company might increase unnecessary operations of the supporting life cycle, thus affecting overall costs.

Speaking to the supply phase, the focus should be placed on the selection of suppliers based on factors such as the suppliers' market share and operational risk. The former factor is related to the experience of introduction, which would directly affect the outcome of ERP introduction. The latter is to ensure that the ERP software could acquire renewal and maintenance in the following 10 years of implementation. The possible activity might be meetings with bidders to ensure that each potential supplier could understand the needs of the enterprise and then use the information offered by the suppliers with some predetermined, selective indicators to make further evaluation and selection.

Table 1. Table of Axial Coding

Primary	Supporting	Organizational
- ERP software customization - Combination of ERP and other systems - Adoption consideration on ERP modules - ERP software testing, adding, and modification - ERP data processing and correctness of transformation - Introduction of each phase - Establishment of the prototype system and execution of simulated introduction - Introduction after all the departments of the enterprise are ready - ERP system developers should initially divide the modules and design from the original piece of each software - Valuing the selection and prospective service of suppliers - Selective consideration of the ERP system - Try one's best to use a single system in the enterprise - Establishment of ERP and setting up of software installation	- Clear and precise introduction process and operational procedure - Schedule and plan for ERP specialization - Select and work with the proper consultants - Carefully monitor the professional timing and budget - Confirm the professional participants' understanding toward enterprises and specialty - Execution of professional audition - Pay attention to the professional members' flow rate - Management of documents - Adjustment of the project based on the situation of the enterprise - Preparation of the crisis management plan - Consideration for selecting ERP professional members - Establishment of risk measure and quality confirmation - Establishment of project performance - Execution evaluation of project performance and finished report - Organization of relationship and communication among ERP project team members - Establishment of the organizational structure of the project team	- Establishment of relationships among overall strategy, vision, culture of the enterprise, and ERP. - Identification of the functional requirement of the enterprise and specialization of ERP - Reproduction of corporate procedure - Management of reformation - Establishment of managers' support of ERP specialization and commitment to resources - Train employees - Make the managers or employees understand the benefits of ERP - Understand employees' potential attitude and cognition toward ERP - Support the opinions of employee leaders - Understand the characteristic of the corporation and the traits of the ERP project's leaders - Management of communication within the organization - Knowledge and information sharing in the organization - Inform the employees about the transformation under the capacity of the system - Allow employees of all levels to participate to some degree - Allow the likelihood that the requirement of the system and the organizational structure might be changed. - Ensure that managers will not be overwhelmed by the data of ERP - Establish related internal control policies - Distribution and restriction of the resources of the company - Familiarity and acquisition of new techniques

In the development phase, the main managerial activities are the customization and testing of the ERP software. Whether or not the internal modules of the ERP software could satisfy the needs of enterprises should be evaluated. One of the main considerations in the evaluation is the efficiency of costs. The internal modules which could reduce the operational costs of the enterprises should be adopted. If customization is deemed appropriate, managers should carefully focus on the degree of customization and pay particular attention to the fact that excessive customization may waste the budget dollars and also affect the performance of the introduction. New errors in the customization toward ERP should also be properly addressed.

In addition, if an ERP system were divided based on modules and modification, or if the customization were faithfully carried out, the processes in this phase would be easier to manage. However, managers should pay attention to the

integration of ERP and the legacy system in general- the systems that would coexist with ERP in particular. For some industries with better vertical characteristics of integration, the connection and compatibility issues of one ERP to the ERP of other enterprises may also be taken into consideration. As to the infrastructure of ERP, the basic structure of the whole ERP should be established before disposition. In summary, the main issue of this phase centers on the installation of software and hardware.

As to the establishment of software, any experience gleaned from a previous module implementation should be analyzed and considered when dealing with modification. An over-standardized setting may considerably affect the efficiency of departments dealing with the requirement of customization. The reason is that if the settings of an ERP do not comply with the requirement of the department, any data printed on forms would not reveal anything worth referencing.. The final step is the test of ERP, which is performed with regard to the results of the customization, as a way to look for possible bugs and problems.

The next stage is the launch phase. First, managers should take care of the ERP data processing and establish the control procedure to transform the data. As to the process of transformation of managerial data, the efficiency, correctness, and rationality of the data input should be the focus. With regard to the legacy systems of the company, the integration between ERP and these systems and the issue of information sharing should also be considered. Before the formal introduction of the ERP, the system of the enterprise model can be established to stimulate the situation of introduction and to prevent possible problems. It is also the manager's responsibility to ensure that all members of the enterprise are ready without undue haste. This method of introduction was suggested based on the phased approach, which allows for a gradual introduction- the departments pegged for a later introduction can follow the experience of the departments that followed before them. Through this interdepartmental interaction, the two cooperating departments enhance their overall understanding, and increase the likelihood of a sustainable initiative acceptance.

After the launch, the maintenance phase should be the next focus. The main focus of this phase is to modify the errors of the ERP system and expand functionality in the system according to the actual requirements. These activities are consistent, and managers should pay attention to activities such as deleting errors or adding functions. Additionally, they should work to prevent the errors of other programming due to the modification of mutual variables, files, and/or database of the system.

Supporting life cycle

In the supporting life cycle, related managerial activities exist to support the activities in the primary life cycle. In brief, in order to ensure the smooth operation of the ERP system in the whole life cycle, the ERP system itself should be carefully managed, as well as taking into account any other replenished managerial activities (or supporting managerial activities).

The first activity which should be dealt with is project management activity. If the primary life cycle is regarded as the primary function of the ERP system, then the supporting management, which is generated with the primary life cycle and which crosses all the phases of the primary life cycle, basically refers to project management. Before the start of the project, managers should consider all the possible steps and attempt to understand the activities inherent in the project as a whole. The tangible missions should contain the detailed instruction for prospective introduction. As to the routine missions, the operational procedures of each phase should be established. During the process of planning, the schedule to carry out the project should also be set up to properly inform employees. A well-planned schedule would be conducive to project management activities. However, the formal launch date should not be fixed. Managers should wait until all departments within the organization are ready before the system is introduced.

With regard to employees participating in the primary life cycle, managers should ensure that each participant understands the operational procedure of the enterprise and the ERP project. If the scale of the ERP project is too wide, the manager could consider modifying the ERP project (i.e., decomposing it into several sub-projects) as a means to enhance operational efficiency and communication of the project. The numbers of projects in parallel introduction, and the process of introduction versus degree of integration should also be taken into consideration. Members of the project team should include the organization's best employees. The internal personnel of audit, in particular, should participate from the beginning (stage one), being careful to not overload the project team with additional missions. Since the leader of the project should have sufficient techniques and past experiences at their disposal, the occasions and/or opportunities to substitute different leaders at different phases of system introduction by seeking the assistance of external experts may be recommended. Managers should also assign experts to control the financial detail of the project and the procedure of introduction. Since project team members come from each department within the company, and in the case of transnational organizations, from anywhere in the world, managers should pay close attention to the communication and coordination of the project, the cultural differences and verbal conflicts among the members, and the problem of lack of trust within a team. In addition, managers

should closely maintain association with the leaders of the project in order to establish the right channels of supervision and communication, and efficiently control the inputs into each phase of the primary life cycle.

The documents which are critical to each phase: from the acquisition to maintenance, such as the analytical analysis of the acquisition phase, supplier invitation documents, programming documents of the development phase, operational manual for the launch phase, and modification document of the maintenance phase should be carefully managed and kept. Otherwise, it could result in the failure of ERP introduction. The critical point for document management is the establishment of standard procedures of document production, utilization, modification, and renewal operations. When modifying and renewing the documents, detailed historical records which describe the reasons for revision should be kept to inform related personnel. In addition, employee training should comply with the requirements specified in the documents, thereby ensuring the process of document management is fully linked to the performance of employees receiving training.

Since there are many potential risks during the introduction of the ERP system, the establishment of strategies to perform risk analysis and establish a quality-compliant environment may not only identify/locate the risk associated with the primary life cycle, but could also ensure the quality aspects of operational activities. The risk can be displayed in monetary figures for a better understanding. A quality-compliant environment necessitates the establishment of a quality policy.

Managers should carefully monitor the schedule and budget of the primary life cycle. The potential schedule and cost for convenient monitoring should be employed to check if the actual results would exceed the original setting. Although it is difficult to control the schedule, the control to have a lower cost is more feasible. Thus, a constant monitoring instrument and/or process is very important. Furthermore, the failure could be regarded as an example to carefully control the schedule of the primary life cycle and resource consumption and/or assignment. As mentioned earlier in the phase of project management, internal auditors should participate in the ERP project from the beginning. Their participation is primarily aimed at auditing the ERP in the primary life cycle. As for the consistent supervision mentioned previously, this study also points out that the audit should be a repetitive operation to be executed at each phase. Any potential problems should be uncovered as soon as possible in order to prevent the occurrence of any other long-term issues. In order to audit the primary life cycle of the ERP, the auditing indicators and criteria should be established at the beginning of the project. The measurement of these indicators should include the tangible aspects of techniques and operation and the intangible aspects (such as communication and the morale of employees in the project). Another important matter worth noting is that the setting of measurement should be easy to understand and implement. Managers should also notice that since the scope of the involvement with ERP introduction is considerably wide, the estimation of measurement would be somewhat difficult. Therefore, when establishing the measurement, the agreement of each department should be secured, and the subsequent modification should be made according to the actual situation. It is also critical for managers to note that before the execution of performance evaluation, they should allow the employees to fully understand the procedure of performance evaluation in order to avoid any future misunderstanding. At the end of each phase, a complete report should be prepared to concretely present the evaluation of the results of the entire phase, allowing auditors to scrutinize the document and look for the reasons of failure as a good reference for the next stage.

The last phase is the problem resolution phase. During the primary life cycle, there might be problems which occurred due to the lack of experience. Most companies would look for the assistance of consultants to resolve these conflicts and/or problems. Thus, selecting an experienced consultant is an important issue. The candidate consultants should sufficiently understand the ERP system and possess professional knowledge in accounting, management, and information technologies. In addition, managers should totally trust the ERP consultants and be prepared to discuss with them any problems that may arise. Managers should also prepare a set of working plans for dealing with crisis resulting from unexpected problems.

Organizational life cycle

Organizational life cycle refers to the managerial activities of the entire organization. Thus, it should go beyond the concept of just phases. In other words, the activities in the organizational life cycle should not be restricted by time. The main reason for this is that all enterprises regard persistent and consistent management as their main objective. Following this logic, the managerial activities in the organizational life cycle would never end and would not be restricted by certain time and space limitations. Compared with the prominent characteristic of phases in the primary life cycle, the role of the supporting life cycle is merely attached to the primary life cycle, while the organizational life cycle values both the past and the future.

The first phase that should be dealt with is the management phase. If the enterprise were to be compared with the human body, the structure that directs the operation of each organ would be the nerves. In order to allow the operation of the ERP in the enterprise to run smoothly, managers should consider the situation, vision, strategy, and the propriety of the ERP system to develop its strategic direction, deliver it to all employees, and control the changes

of the environment at any time. The purpose of this is to adjust/modify the proposed strategy of the enterprise to meet with real objectives. Subsequently, managers should analyze if it is necessary to introduce the ERP. To accomplish this, they should proceed with an accurate analysis of corporate requirements and confirm the needs of the enterprise with regard to the utilization of ERP. With regard to the different traits of the organization, the more that the departments rely upon each other or the higher the standard of production, the more beneficial the adoption can be. If the procedures of certain departments are considerably different from the ERP, it may not be necessary to modify the procedures of these departments to comply with the ERP. However, more cost and time to integrate the systems and operating procedures are most certainly required.

In order to introduce the ERP, managers should efficiently distribute/assign the resources of the company. To ensure smooth operation upon introduction of the ERP, specific and exclusive resources should be made available. Managers should remember that the plan of ERP introduction is the most important activity within their organization, and is no doubt the priority. Managers should support and participate in the process of decision making so that the employees of each administrative level can recognize the value of the ERP introduction plan. Apart from managers' appreciation toward the benefits of ERP, the employees should improvements will affect the requirements of their job, ensuring they better support their managers. The control aspect which is inseparable from management also plays an important role in this stage. Managers should initially understand the internal control environment of the company and the procedure of the accounting system. With the trading control function of the ERP system, its internal control procedure could be planned or modified to establish a control procedure which values simplicity, safety, persistence, and regular monitoring instrument after ERP introduction. Regarding the personality of managers, they should be persistent and enthusiastic toward the ERP system and should care about the welfare of their subordinates Additionally, managers should realize that since there is plenty of information about the ERP, they should be able to distinguish between useful and non-useful information and avoid being overwhelmed.

In the communication phase, since proceeding with the reproduction of corporate procedure, one must tread through the traditional system of authority division in order to solve the conflict of functions in the legacy system. The creation of new positions and new departments should be clearly communicated, and managers should pay attention to the reaction of their employees when delegating new duties, tasks, and/or responsibilities associated with new positions. They should also communicate with them the newly required professional capacity and structure of job roles under the new system. It is better to allow all employees to actively participate in the introduction of the ERP, which ensures they will access the system in the future with minimal manager interaction. With regard to internal communication management, managers should demonstrate leadership and authority as a means to increasing overall ERP performance. Managers can assign the teams specifically involved in the communication process to be in charge of interaction with employees as they progress through each phase.

In addition, the communication among employees is also important, particularly the communication between users and developers. For companies under geographic restrictions, the use of communication technology to assist in the effective interaction of team members is a must. Whatever the methods are, leaders should consistently strive to solve the conflict arising from inefficient communication and subsequent resistance due to differing points of view. During the process of communicating with employees, interaction with the designated employee leaders should be maintained and supported. Effective communication diminishes misunderstanding and shortens the gap of knowledge transfer and distribution between the introducers and end users. Thus, information sharing is critically important for companies to engage in. If there is a shared value in the corporate culture, the acceptance required of a new idea is easier to come by. Efficient and frequent information exchange is critical to the implementation of new projects, the recognition of potential risks, the improvement of performance, and the satisfaction of clients' needs.

As was the case in the improvement phase, the first problem to be tackled is the reformation of corporate procedure. Managers should recognize that a good corporate procedure can ensure the competitiveness of the enterprise. Thus, the change in procedure due to the introduction of ERP should be highly valued. When designing a new operational procedure, the best procedure of the same industry may be the right one to follow. The operational model developed must acquire the consensus of all members. In fact, the effect of reproduction of procedure upon the enterprise is more than that of information technology. Due to the change in the environment, the life cycle, and the requirements, the organizational structure of the enterprise might be changed accordingly. Thus, managers should pay particular attention to the changes made to the current situation because these changes will affect the development and design of the ERP, or even lead to a different outcome of applying ERP technology. Improvement leads to changes. Consequently, managers should value the process of reformed management and plan first for the control procedure of reformation. Each operational unit should cooperate in order to proceed with the reformation. In addition, organizational culture, information technology capability, knowledge power, balanced network relationship, and learning capacity can all enhance the change of procedures and the management of reformation.

Training phase. Prior to the training phase, managers should recognize and evaluate the employees' attitudes toward the introduction of new techniques. Since the employees' resistance to new techniques could be mainly due to their diverse recognition of risks and habits, managers should verify their employees' understanding of the ERP technology in order to address the issue of their resistance and hence promote ERP. The degree of ERP recognition of employees who are without an information technology background could affect the overall promotion and application of ERP. Formal training can allow users to establish the correct attitude toward ERP implementation and understand the change in corporate procedures and the idea of how to use and operate the system, access, and store data in the system. Thus, determining how to enhance an employee's learning capability and interest is an important factor to consider. Initially, managers can train employee leaders, and allow these leaders to properly instruct the other employees and their subordinates. Additionally, the educational training should comply with related guidelines of the ERP system. If necessary, managers can proceed with duty transfer or cross-department training to enhance the employee ERP learning process. Some common problems with regard to training include: promptness in starting, few people attending, not training the right personnel and the insufficient level of training performed. Managers should always remember that there is no end to employee training. The enterprise's vision and strategy should echo the policies and training procedures implemented by management.

The authors organized the relationship among the life cycles of the managerial models as shown in Figure 3. In this operational framework, managers should use the organizational life cycle to establish the primary life cycle of the ERP and proceed with management control of primary life cycle activities through the supporting life cycle. The information generated by the supporting life cycle would then be passed to the organizational life cycle. The detailed content of each life cycle is shown in Figure 4. It should be noted, however, that the primary life cycle is related to time. Each phase is in order, which is similar to the previous discussion about ERP. As to the development phase, this study pointed out that the design, modification, system testing, launch, maintenance, and the customization in empirical cases should be carried out according to the change in requirements of the enterprise, user demands, and the renewal of functions. It is for these reasons why the development phase is unique to all others.

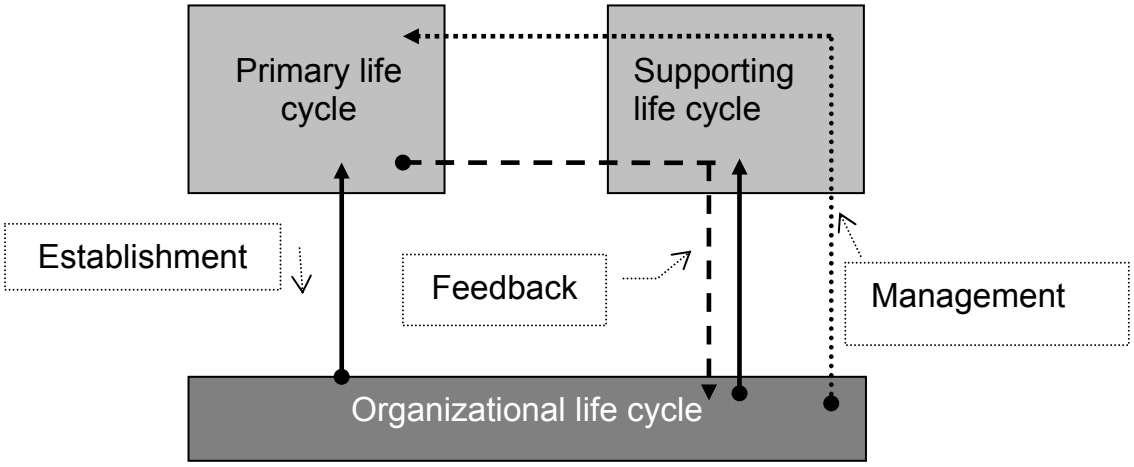

Figure 3. Operational Figure of the Managerial Model of the ERP System

V. VALIDATION BY DELPHI EXPERTS

Based on the research strategy defined earlier, this study proceeded with Delphi-type expert validation to the prototype reference model. A two-round, non-anonymous Delphi-type open survey was conducted, using personalized e-mail with attached survey instruments. Chang and Gable [2000] critique the Delphi method in the context of IS key issues studies and its application within the context of the current study. Through the pre-selected and by-invitation processing of survey participants from designated categories (i.e. information service industry, electronic manufacturing industry, academic and governmental), we have mailed 40 expert questionnaires for experts and each categories included 10 participants. The Delphi method in this study consisted of two rounds. The respondents were asked to assess the importance of these activities of ERP life cycle in the two round Delphi. We have received 27 and 24 questionnaires returned in the first and second round survey respectively, and return rate was 67.5 percent and 60 percent respectively. If the consistency of two rounds was reached, we would not employ next round Delphi. The description of these experts is shown in Table 2.

Using SPSS software, the authors performed statistical analysis on the responses collected from two rounds of Delphi questionnaire. These responses were subjected to an average test of pair samples (t-test). The results of the statistical analysis were then interpreted. The decision criteria were when the prominent standard $\alpha \square 0.05$, apart

from one option, the p values (prominence) of the rest of the options are over 0.05; meaning that the hypothesis of "there is no statistical prominent difference of the results of the questionnaires of the two phases" should not be rejected. The difference between the results of the questionnaires from the first and second stages was not prominent. In other words, all the opinions of the research subjects were consistent, and therefore, there was no need to proceed with the questionnaire of the next phase. The opinions of the experts of the two phases were basically the same. Besides, since the standard deviation (SD) of the results of questionnaires from the first and second rounds were little, the SD of the second round was less than that of the first round, and each option reached convergence.

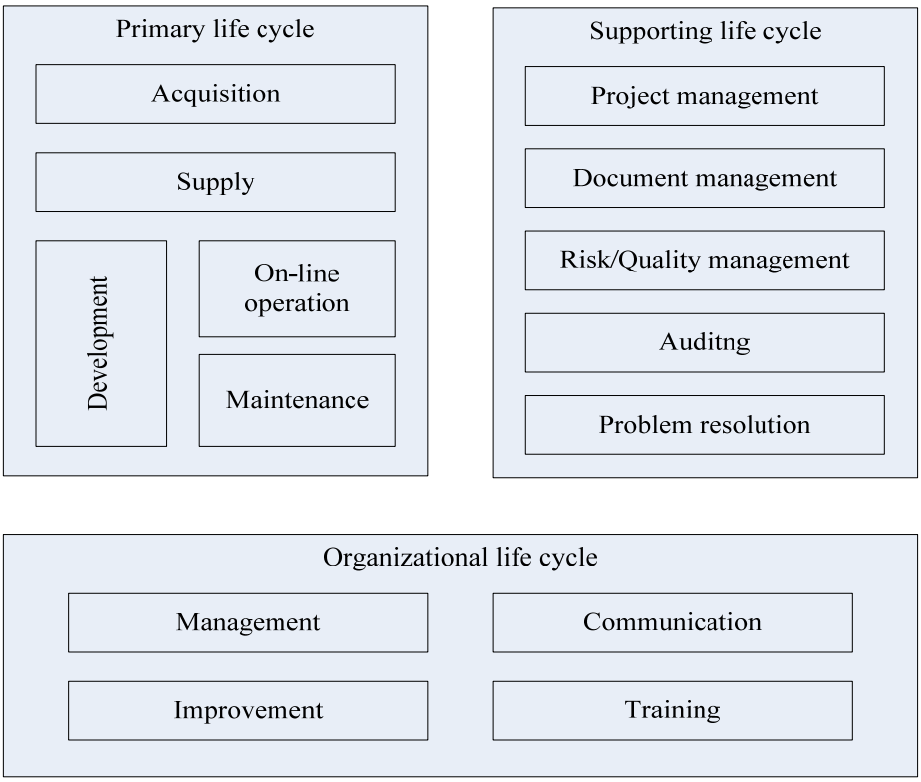

Figure 4. Structure of the Managerial Model of the Life Cycle of ERP System

Table 2. Establishment of Delphi Experts

Expert service industry	Reason for being selected as the primary consideration	Participants (I)	Participants (II)
Information service industry	Experience in introducing ERP	7	6
Electronic manufacturing industry	Participated in the introduction of ERP to management of enterprises	6	5
Academia	Studied ERP for many years	6	6
Government	Participated in the assistance of e-business	8	7

All options are not to reject the hypotheses. One prominent option was the "introduction after all departments of the enterprise are ready." Although the option passed the consistency test, its SD (1.16) was higher than the average (0.64) of all questionnaires. This means that some of the research subjects revealed extreme opinions. The result, however, did not affect the consistency.

The scores of each option were ordered based on the average (i.e., from maximum to minimum) with respect to the first and second experts' questionnaires. It is interesting to note that the experts believed that the most important managerial activity was managers' support to the ERP project, the commitment to resources, as well as clear and defined introductory process and operational procedures. As to the top 10 managerial activities, the one related to managers was "the traits of the managers." To this end, managers have, no doubt, the most important role in the life cycle of the whole ERP. In addition, among the top 10 managerial activities, there were five from organizational life cycle and three from the primary life cycle. This means that when facing the life cycle of the ERP system, managers should be more concerned about the issues surrounding the organization as a whole instead of the ERP in itself. In the primary life cycle, the managerial and communication phases appeared to be the most important. Thus, in the

organizational life cycle, managers should pay particular attention to the aspects of management and communication.

In addition, when comparing the scores of the two rounds of each life cycle, the activities can be organized to show which options have a difference of over 0.3 in terms of the score. Table 3 shows the summary of these results.

Although the scores in the two activities in the organizational life cycle were considerably different, the scores in the second activity were always higher than the first. Thus, it is evident that the importance of organizational life cycle was identified by the experts. As to the activities of the primary life cycle and the supporting life cycle, the consideration on the adoption of ERP modules, the establishment of risk evaluation, and the confirmation of quality were reduced prominently. Thus, experts believed that these were not the activities that should be the top concern of managers.

Table 3. Comparison of Scores of Options

Primary life cycle		**1st_A**	**1st_S**	**2nd_A**	**2nd_S**
Phase	Critical managerial control activity				
Development	Adoption of consideration on the ERP module	4.7	0.67	4.2	0.63
	Dividing modules and designing from the material of each software	3.2	0.79	2.8	0.63
Organizational life cycle		**1st_A**	**1st_S**	**2nd_A**	**2nd_S**
Phases	Critical managerial control activity				
Management	Identification of the functional requirement of the enterprise and the specialty of ERP	4	0.67	4.6	0.52
Training	Understanding employees' potential attitude and cognition toward ERP	4	0.82	4.4	0.52
Supporting life cycle		**1st_A**	**1st_S**	**2nd_A**	**2nd_S**
Phases	Critical managerial control activity				
Management risk quality	Establishment of risk measure and quality confirmation	4.6	0.70	4	0.67
Audit	Proceeding with the evaluation of performance and reporting the end of evaluation	4.4	0.84	4.1	0.74
Problem resolution	Formulating a plan to handle the crisis	4.6	0.70	4.3	0.67

With regard to the ranking of single activities, the supporting life cycle was not the highest. However, if the total average of the scores of the three life cycles were added, some interesting results are shown (Table 4). The total average of the second round of supporting life cycle was the first, and the scores were much higher than that of the primary life cycle. The experts thus believed that the managerial activities of the supporting life cycle were actually important.

Table 4. Total Average of Scores of Life Cycle

Numbers of rounds of the Delphi method	Names of life cycle	Average of total scores	Ranking
First round	Primary life cycle	4.15	3
	Organizational life cycle	4.35	2
	Supporting life cycle	4.47	1
Second round	Primary life cycle	4.06	3
	Organizational life cycle	4.43	2
	Supporting life cycle	4.46	1

Based on the previous discussion, managers should initially pay attention to the life cycle of related organizational activities, which are broken down as follows: management, communication, improvement, and training activities. Deemed as most important were the activities at the managerial phase that value the managers' support of ERP project initiatives and the commitment to resources. Thus, the outcome of ERP introduction is heavily dependent on the attitude of the individuals introducing the concept into the organization. In other words, total manager support would positively impact the performance of an ERP system. In addition, the communication phase of this life cycle should be highly valued, and include managerial issues among the project team, between the team and other employees, and between the managers and all employees.

As to the primary life cycle, managers may simply ignore this part in general. The main reason is that this cycle requires involved professional knowledge. Without a solid background in information engineering and information management, it might be difficult for a manager to participate in this particular part of the process. However,

managers should pay attention to “the selection of an ERP system” since it is rather important to spend the time needed to understand if one particular system is suitable for the enterprise or not.

In the supporting life cycle, although the managerial activities were for the normal operation of the primary life cycle, this element should not be ignored. The reason for this is that the supporting life cycle represents the daily operations of the enterprise from project management, management of documents, management of risk and quality, and all the way to audit and problem resolution. Overall, the supporting life cycle plays the role of a bridge in the managerial model, which connects the primary life cycle and organizational life cycle.

V. CONCLUSION AND SUGGESTIONS

This study applied both the results from the literature review and Delphi study on the basis of Gowin's Vee Approach. In reference to the literature review, this research used the Grounded Theory to construct a prototype of a reference model which contains three main lifecycles and 52 critical managerial control activities for ERP life cycle-wide management and support. Subsequently, this study used the Delphi Method to collect the opinions of field experts. After analyzing and organizing the results of two rounds of Delphi survey, comparison and amendments were made to propose a final set of reference models for ERP life cycle-wide management and support. The model can function concurrently as a method of reference for an academic study on the life cycles of the ERP system. Furthermore, we have constructed a framework on ERP systems by investigating managerial control activities in the ERP life cycle. This different approach was compared from a stage management point of view in order to emphasize critical activities, and it offered directions and trends for prospective research areas. As for the business sector, this proposed managerial model can be utilized to assist a large enterprise with a current ERP system and can offer small and medium-sized enterprises a set of structures for the successful introduction of ERP. The managerial models of the life cycle of ERP consisted of three parts, namely, primary, supporting, and organizational life cycles. The managerial model expected that managers initially accomplish the related activities of the organizational life cycle in order to manage the primary life cycle (introduction of the ERP system). The supporting life cycle is necessary to ensure the normal operation of the primary life cycle. Only the activities of the organizational life cycle would continually exist in the enterprise. The supporting life cycle is attached to the primary life cycle. In other words, if an enterprise were to replace its ERP system, the supporting life cycle would be changed as well. The supporting life cycle plays an extremely important role in the managerial model, which allows managers to control the schedule of the primary life cycle through the supporting life cycle, and also offers related data for the managerial activities.

Since there is no definite statement of the managerial model of the ERP system, and there are various studies exploring the project management, this research used the Grounded Theory to integrate the managerial activities mentioned. It then examined and explored the related information of prior research from a new perspective in order to avoid the prejudices of prior studies toward the life cycle of the ERP system. The Grounded Theory is one of the important research methods for qualitative studies, and it can generalize the original data, organize statements and concepts without any research hypothesis, and upgrade existing concepts as theories. Although it is a good research method, it is restricted by the subjectivity of the authors. Through different researchers’ thoughts and logic, the same research phenomenon might generate different results. Therefore, this paper suggests that future studies may apply this model as the basis but should use a wider and deeper Grounded Theory to create the perfect model.

Although this research used the Delphi method and collected the experience and opinions of experts with related experience in ERP — particularly consultants from companies that already introduced the ERP, the research lacks empirical validation. Managerial activities require the accumulation of experience, and it would be good to proceed with the records of enterprises that have had ERP implemented in their organization for a longer period. Furthermore, this paper suggests that when proceeding with related studies on the life cycle model, prospective researchers should prolong the time span of the study. It is better that they participate in the process before, during, and after the introduction of the ERP system in order to obtain more profound results.

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