

# A Three-Stage-Model of e-Enterprise for Construction Contractor— A case learned in Taiwan

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## Abstract:

Taking advantages of the advanced information technology, more and more construction businesses begin to adopt the large scale information system, such as web-based project management system, Enterprise resource planning (ERP), supply chain management (SCM), electronic knowledge management (eKM) and so on, to improve the management efficiency and productivity. However, it seems there is no effective model for evaluating and implementing an e-Enterprise. A survey of computerization in Taiwan construction contractors shows that on account of lacking the information technology support, the traditional Nolan and technology transfer Model cannot provide a good suggestion in the process of e-Enterprises. A Three-Stage-Model of e-Enterprise, which based on the information technology, will be proposed in this paper. This model can not only evaluate but also implement an e-Enterprise. This paper also discusses about the e-Enterprise's case of Taiwan construction contractors, and give some suggestions for their e-enterprises process.

## Introduction

The information technology (IT) has a significantly improvement in the past decade. According to the hardware enhancement and Internet development, there are many new type commercial activities coming into existence, such as e-Business, e-Bidding, e-Marketing and so on. The management manner has also a great revolution. The Enterprise resource planning (ERP), supply chain management (SCM) and electronic knowledge management (eKM) have been introduced into the Business, reforming the framework of the organization and altering the process of their activities. More and more businesses commence to progress the e-Enterprises, using the IT to handle the regular businesses activities, data, transaction and get strategic decision support.

Due to this phenomenon, the evaluation Model of computerization for the Enterprise has become very important. The Nolan Evolution Model is the most famous one that is referred to this objective. In accordance with the attributes of DP expenditure, Application Portfolio, DP organization, DP Planning and Control User Awareness, it discriminates the computerization's evolution process of a Business into five gradations, which are Initiation, Contagion, Control, Integration, Data Administration and Maturity.

Although this Model provides an evaluation index of computerization, there are still some issues about it. Zuurmond indicates that the Nolan evolution Model cannot provide an appropriate implemental definition for the computerization's evolution. Drury also points out that there are many ambiguities in its

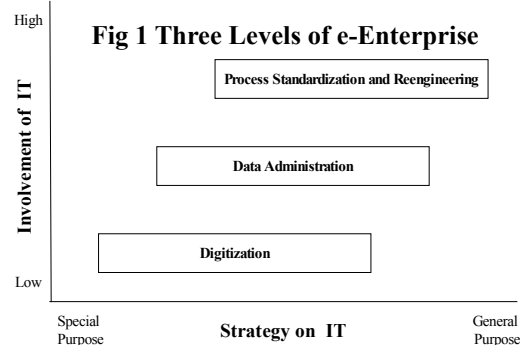
wording, variable and the relationship. The researchers need to define and interpret them by themselves, causing the obstacles in comparison with different research's reports.

On the other way, according to the development of the IT, the classifications that the Model adopted fall behind the tidal current, and many characteristics related with the technology are not contained in it.

Therefore, a Three-Stage-Model of e-Enterprise, which based on the information technology and organization management, is proposed in this paper. This model cannot be used only to evaluate but also to implement e-Enterprises. And a case study of the e-enterprises process for the Taiwan Construction Contractors will be discussed in this paper, and some suggestions about then will also be given.

## Three-stage-Model of e-Enterprise

The Three-Stage-Model of e-Enterprise is based on the businesses' strategies and involvements of the Information Technology. It classifies the process of e-Enterprise into three degrees, which are Digitization, Data Administration, Process Standardization and Reengineering. As the Fig 1 illustrated, the



Digitization has the Special Purpose and the lowest involvement on IT, so it is the first degree of this Model. The Process Standardization and Reengineering has the General Purpose and the highest involvement on IT, therefore it's the last level of this Model, and the data administration is the second level of this model.

### Level One: Digitization

The first level of this model is Digitization, which means to record and manipulate the businesses activities' data, or process control by using IT. Generally, an isolated system is introduced into the businesses for particular strategy in the level. For example, a 24-hour, toll-free custom service to enhance service; CAD/CAM capability to reduce the manufacturing cycle time and enhance quality. Since the operations it deals with are generally regular and high repeatable, no business's schema it involved, it usually is called as automation. Although the IT involving in this level is the lowest and the businesses' strategies are specific, it still has an indelible contribution for the e-Enterprise. It can be as the feasibility test for the advance computerization and the foundation for the next level. Furthermore, since its objective is distinct and doesn't need a lot of businesses' changes, its outcomes can be easily surveyed.

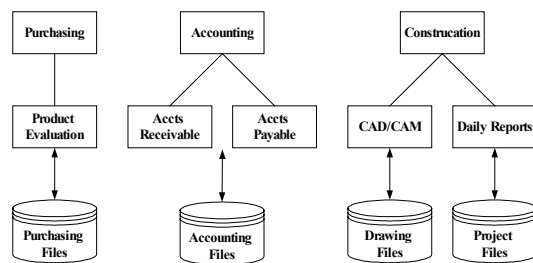


Fig 2. Digitization for special purpose

### Level Two: Data Administration

Although the first level of e-Enterprise can provides a way of businesses operations' enhancement by using IT, it is not enough for the regular activities of businesses. Firstly, all the data from the first level computerization are unsorted, there still are many redundancy and inconsistent of them. They need to be further refined and organized. Secondly, the applications of file-oriented-system of the first level have heavy loads on data maintain and hardly to share with other applications or departments. To overcome these defects, a second level of computerization has been proposed in this paper. It is Data-Administration, which means to use database technologies to manipulate and manage

the data produced from the enterprises' regular activities.

The first step of Data-Administration is to purify the data, keep them simply and no redundancy. The E-R Model can be used here to achieve this goal. Within the E-R model, all the data should be divide into several entities. An entity is the most simplifivative metadata unit that is comprised from the data fields (attributes). All the attributes of the entity are function dependant on its prime key, there is no redundancy and inconsistent in the entities table. A primary key is used to identify a specific record of this table, which is composed by one or several attributes of this Entity. And the Entities can be joined into a bigger table by their reference keys. The businesses' regular activities' data are recorded in these bigger tables. And the process that dividing the source table into entities usually is called as normalization.

In spite of the E-R Model has a great helpfulness in Data-Administration, there is still a critical issue should be solved in this process, which is the data authority. Traditionally, the organizations in an business are used to build up the database system of their own. There are many incompatibilities between these systems, causing the obstruction for the information circulating, affecting the enterprise to make an appropriate decision in good time, and reducing the efficiency of businesses' operations. It is even more serious in a huge business. Many businesses spend a lot of time and money not on the database system building up but on the transformation from one system to another one. So how to convince the organizations in a business to give up the fully control on the data and share them to the others will be a key point in the success of e-enterprises' process.

According to the development of IT, this issue can be solved easily by 3-tiers system. As figure 3 showing, this system divides the businesses' service into three logic layers, which are presentation layer, business layer and data access layer. All the end users, no matter which department they come from, can access the business data according to their authority degree through the same interface in presentation layer. There is no extra data-transformation's manipulation in the client. The business layer will carry out the necessary data manipulations for it. And the data access layer is in charge of the data administration about the databases and business operation. This system can provide flexibility for expanding. It doesn't need any change in presentation layer even though the business logic or data access logic is changed. It deserves to be mentioned here that the centralized database is not essential in this

system. It means that each department can still keep the authority on the data maintaining even thought in the data-integrated environment.

### Level Three: Process standardization and reengineering

As this paper presuming, after the second-level computerization, the businesses should have built up a fully integrated data exchange system in the organizations, all the information can be transferred at liberty in the businesses, there are no time differences between the organizations. However, that mentioned above is just confined to the scope of data management, not yet involved any workflow refinement. It is passive to record the data produced from the regular activities of a business. There is still a

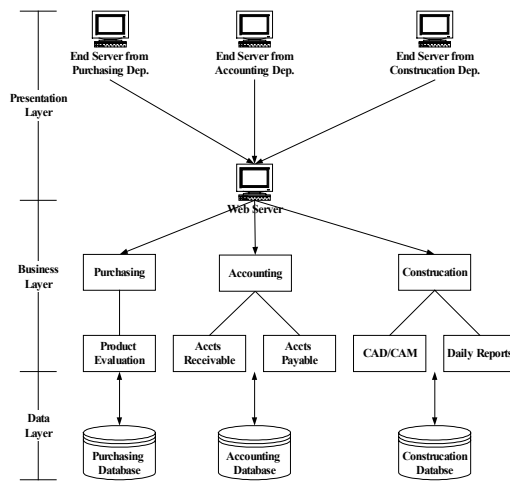
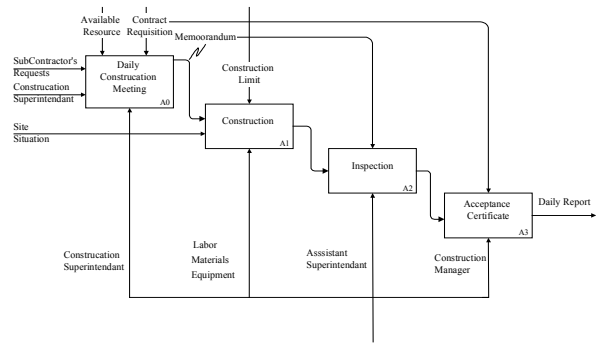


Fig 3. Data Integration by using 3-tiers system

room for improvement. After analyzing on the data flow that comes from the second level, an appropriate and efficient business activities model can be proposed for the process standardization and reengineering. The Figure 4 is an example for process standardization and reengineering by using the IDEF. It shows that how the interaction between the data model of second level and the process control in third level.

Exactly as many literatures strongly indicating, the IT functionality of this level should not be simply overlaid on the exiting business processes but be used as a lever for designing the new organization and associated business process. It usually needs the support from the high authority, therefore to overcome the resistance from the chiefs of each department.

According to the description above, the characters of the three levels of e-Enterprise can be summarized as table 1.



### A Case Learned in Taiwan's Construction Contractor

In preceding section, a Three-Stage-Model of the e-Enterprise has been proposed. It can be a reference for businesses on their strategies of IT. And two representative cases about e-Enterprise of the construction contractors in Taiwan will be discussed in this section, which are the Bes Engineering Corporation and Continental Engineering Corporation. They are continuously the first 10 businesses of construction contractors last three years, and their strategies on the IT are very different. It can give meaningful information about the e-Enterprise of the construction contractors of Taiwan in compared with them.

#### Case I: BES Engineering Corporation

The BES Engineering Corporation is founded in 1950, which has 119.26 millions NT dollars in capital assets and 728 employees now. There are five departments in it; they are Construction Business department, Landing Development department, Management department, Investment Business department and Financial Affairs department. The information office is subordinated to the Management department, which has one managing director and 21 members in it. The Information operation center has been set up in 1968, in charge of driving the organizations' computerization. It has derived the responsibility information system, integrated the site management system, developed the office automation and built up the whole communication network between the intranet and extranet since 1991. The network office has been set up in June 1999, it is in charge of lending an impetus to e-Business of this Business and its Group. In March 2000, the network office and the information office are united into the e-Business office, it does not only drive e-Business of this Business and its Group, but also takes transactions from other companies, assists them in e-Business, integrates the Information systems of them, make them to achieve the target of B to B and B to C.

**Table 1 A summary of the three levels of e-Enterprise**

| Level of e-Enterprise                     | Business's strategies                                      | Relative with organization     | Key factor              |
|---|--|--------------------------------|-------------------------|
| Digitalization                            | The business's operation capability enhancement            | Inner-organization             | Outcome's benchmark     |
| Data Administration                       | The data integration and sharing between the organizations | Inter -organization            | Data authority          |
| Process standardization and reengineering | The operations' flow path refinement and standardization   | Inner- and inter- organization | Organization modulating |

The principle development policy of the Bes Engineering Corporation is to build up the information system by itself. After a long time efforts, there are construction estimation system, personnel matters and salary system, invoice and collections system, daily report system, material management system and so on having been accomplished. The database systems that they used cover from the Oracle, SQL server, Paradox to the Dbase. The development tools also include Oracle developer 2000, Clipper, FoxPro and VB. They also use P3, Sure Trak, Oplen Plan for their project management, and the Lotus Notes as their OA system.

Due to the tidal wave of e-Business in recently years, the CEO of this corporation gives every effort to drive the e-Business. They didn't only invite scholars to company, conducting two series classes of e-Business for the higher chiefs, but also expanded the staffs related with information business, evaluated various investments and lend an impetus to relative tasks about e-Business, which including the B2B electronic procurement, constructions' resource dispatching site, electronic market of Construction and the ASP service. However, since the variation and immaturity and there is no profits-making case in e-Business market, the most investments about e-Business have been suspended finally.

Being conscious of lacking integrated information, the business policy turns to the e-Enterprise in the interior. They begin to drive the ERP and the management-decision-support system of the business. It is no longer predominated by the information office but by the each department respectively. The information office is back to the scenes as the role of support, and all the systems are still developed by itself in principle.

The fail of the diversification for the Bes Engineering Corporation has shown the importance of Internal integration. Without it, the Business is difficult to reengineer its business process and redefine its business scope, because the inefficiency of the message transfer will reduce the business's operation effect,

prevent it from making appropriate decisions in good time and bring the communication obstacle to the organizations. For example, it usually spent a lot of time for the Construction Contractor to deal with the misunderstanding between the Constructions and Procurement Department. The efficiency is of course incapable to enhance, even more the business scope redefinition.

In fact, according to the criterion addressed up in this paper, the Bes Engineering Corporation is merely refereed to the degree between the Level One and Level Two. There is not yet a fully integrated-information system in it. It still devotes itself to e-Business, so causing the disharmony between the organizations and the expanding fail.

And the expanding of e-Enterprise about the Bes Engineering Corporation also reveals a interesting information, which the importance of the support from the high authority in e-Enterprise. The driving of the e-Business is not smoothly in early days, it has improvement until getting the fully support from CEO. This is just in accordance with preceding description in this paper. The higher level of e-Enterprise is, the deeper involvement of the organization reformation is. All the data authority releasing and the process reengineering of the departments will face the resistance from the chiefs of them. It is hard to carry out unless get the powerful support from the higher authorities.

**Case II: CONTINENTAL Engineering Corporation**

The CONTINENTAL Engineering Corporation is founded in 1936, which has 765.32 millions NT dollars in capital assets. There are mainly four parts in it, which are Engineering Business Section, Construction Business Section, Administration Section and others. The information department is subordinated to the Administration Section, which has 7 members in it. Although there are no groups dividing in it, its works are still proceeding in two groups. The system group is in charge of hardware, network, support and maintaining of OA software, recommending and testing of new IT, maintaining the applications on the Notes. The application group is in charge

of developing of MIS and maintaining of database system that are mainly based on the ORACLE. Due to the more and more outsourcing information systems in recently years, the focus of job in IT organization has been turned to the outsourcing management.

The information systems that the Continental Engineering Corporation adopts are not plenty, but it has a particular construction information system, which can provide the function of the bids inviting and project management. Although the Continental Engineering Corporation has 51 years in history; its information center for computerization driving is set up until 1989. In 1990, Miss Su succeeded the IS manager, and introduced the Sun Account into the business as its accounting software. It also developed the MIS by itself, and used the ORACLE as the platform. But due to un-integrated of these information systems, the preceding and succeeding process cannot be connected to together. Miss Su felt frustratingly in it and resigned

The successor of IS manager, Mrs. Wu, began with accounting and personnel-matters systems, developed personnel-matters and salary, periodical and foreign workers management system. He intended to give up the old Sun Account system, and rebuilt up a new system that based on the ORACLE. It was online in March 1998, and integrated with other systems. In virtue of the fail experience in the past, the tough style leadership of Mrs. Wu had brought about conflicts with other departments He is also quit and Mrs. Yung became the successor.

Unlike the Bes Engineering Corporation, the Continental Engineering Corporation takes the original businesses defending as their strategy. It first integrates interior information systems then

takes account of ERP, so not facing too many difficulties than Bes Engineering Corporation. And its IS manager has a engineering background, that is contributive in communication with the other departments. However, neither the Continental Engineering nor the Bes Engineering, it also shown the importance the high authorities' support in e-Enterprise, and the degree of information office is too low to in charge of so complicated works.

#### **Conclusion**

As discussion above in this paper, it is clear that a successful e-Enterprise is not depended on how deep the involvement of IT, but on the strategies of IT. A successful business will take suitable manner about IT according to its requirement, and it varies from the digitization to the process standardization and reengineering. It has also been shown that the more complicated strategy the businesses adopted, the more change they needed. It needs the support from the high authorities.

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