ERP Information System Service Quality under a System Dynamics View

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Abstract: - With the growing popularity of ERP, numerous researches have been performed by both academia and industry. Based on the discussion and analysis of the key factors in the successful introduction of ERP, some key factors for success repeatedly appeared in various documents and demonstrated a solid and significant influence. However, the overall situation cannot be reviewed based on just one factor. Therefore, beginning from the interaction between the system demander and the system supplier, this study examines the decision points and links from several aspects which influence perceptions of service of the ERP user using a system dynamic method; moreover, through analyzing the cause and effect loop, this study shows the policy intervention point for the improvement of service quality by the system supplier to enhance perceptions of service, and thus improve service quality. Hopefully, by using the findings of this study system suppliers can implement enterprise reforms and critically improve the important influences on service quality and their degree of association to effectively enhance their competitiveness.

Key-Words: - Enterprise resource planning; Service quality; System dynamics

1 Introduction

1.1 Research background
Recently, along with the growing focus on globalization, enterprise management has developed in the direction of internationalization and specialization. Facing a constantly changing business environment, how to reduce operational costs and actively improve the competitive power and operational efficiency has became the main task facing current decision makers. For analyzing and reacting promptly to the market, Enterprise Resource Planning (ERP) becomes the backbone of enterprise information management, "adopting information technology to achieve competitive advantage" is one of the ten important areas in information system management, indicating that numerous enterprises adopt the strategy of "information technology" to establish competitive advantage. ERP system can improve enterprise logistical efficiency and simultaneously provide an enterprise with accurate and quick decision information, thus improving and resolving the problem of inconformity and coordination between various application systems.

Consequently enterprise business structure and function can be reshaped and improved.

Consequently people have begun to focus on information system quality. Since the 1980's, the market transaction pattern has changed to being customer guided and thus service quality is directly determined by the degree of customer satisfaction. However, the conditions under which customers will really feel satisfaction still need to be determined. The difference between the service expected by the customer before the information system is used and the recognized services following use determine information system service quality. Under such an environment, improving service quality and successfully promoting businesses with which the customer is satisfied so as to increase the transaction life between the customer and the enterprise will be the main means of avoiding customer loss and preventing other competitors from entering into the industry.

1.2 Research motivation and objective
When enterprises introduce information systems, they simultaneously undertake a high degree of capital risk, particularly when considerable funds are to be invested in introducing the ERP system,

and considerable work and staff are involved in ERP introduction.

Once an enterprise fails its loss of business resources and competitive power is inestimable and irretrievable. For the construction of the ERP system, it is not the promotion of single side only, requires not only the assistant of a high-quality software and hardware system and consultant, but also the enterprise's operating power and the determination in the introduction process, which are more important factors for success. To enhance information system service quality, the interaction between enterprises and ERP system suppliers is important.

Taking the interaction between system demanders and suppliers as a foundation, this study examines the decision point and link-to-link relationship between each other from several aspects that affect the sensitive service of the ERP user using a system dynamics approach. Moreover, by analyzing the cause and effect, this study shows the point at which the system supplier should intervene to enhance service quality increase user recognized service, and thus improve service quality.

1.3 Research method

This study analyses information system service quality from the perspective of system dynamics. The system dynamics perspective was designed by professor Forreter of MIT in 1956, and combines the system analysis testing method, decision making theory, information feedback control theory and computer simulation technology as a theoretical basis, and focuses on research on complex dynamic system with the characteristics of "high level, non-linear and multiple loop " [1].

The introduction of ERP involves large numbers of personnel, organization and cost, and the factors are closely connected. Therefore, a systematic perspective and viewpoint is adopted to explain the cause and effect relationship between each other and thus to analyze the system dynamic change of the service quality.

This study adopts the method of system dynamics and takes ERP as an example to study the problem of information system service quality and design a system dynamic model of information system service quality using system dynamic software "VENSIM.0".

2 ERP & service quality

2.1 Key factors for successful introduction of ERP

The key factors for success may vary according to the industry, the product, and the market. Based on previous studies, it is not difficult to find the key factors for success. Most researchers/scholars propose similar ones. So, in order to successfully establish an ERP system, enterprises should pay special attention to these key factors.

The proposed key factors for successfully introducing ERP, according to other scholars, are as follows:

Maskell (1986): in order to successfully introduce integrating software, the following conditions should exist: support from high level management, a specific person assigned to take charge, suitable software for the work flow of the enterprise, and the carrying out of tests before formally going into operation [7].

Bingi (1999): Promises from high level management, enterprise reconstruction, integrated content, an ERP consultant, introductory occasion, introductory cost, an ERP supplier, a properly qualified person, staff training, high staff morale, and coordination of staff [2].

Laughlin (1999): Clear definition of the target, excellent project plan and schedule, strong support from high level management, inter-communication of the target, focus on the solution of problems, restraining the applying range to the predicted scale, previous successful experience, proper project members, excellently trained project management [6].

Wamcocks (2000) proposed the following key factors for constructing ERP: Support and participation from high level management, planning of the introduction schedule, organizing of all highly motivated staff, considerable information technology capability owned by the enterprise itself, establishing an excellent project team [10].

Kip and Win (2000) deems that: The introducing scope should not be too wide, the project progress should not be lead completely by the consultant, not too many systems from different suppliers should be adopted, the fundamental module should be introduced first; a system that is suitable for the customer's requirements and the target of the enterprise itself should be selected; the technique specialist should allow/let the members of the software supplier to participate in the project and should

establish a partnership with them [5].

2.2 Integrants and factors of service quality

In 1988, using a factor analysis method, PZB abstracted the ten integrand sin to five integrands with high reliability and effectiveness with smaller overlaps: Reliability, Tangibles, Responsiveness, Assurance and Empathy and developed a quantity table for assessing service quality, which is generally termed "SERVQUAL". The table included the five integrands and 22 related questions. Traditionally the service qualities are all assessed using this quantitative table, but recently scholars have proposed using the multidimensional and hierarchical method to evaluate service quality.

2.3 Method of evaluating service quality

Gronroos (1984) developed the comprehensively recognized service quality mode, indicating that enterprise image, as well as technical and functional quality can influence service quality. Furthermore, in 1984, based on the mode proposed in 1982, it was deemed that consumers can reliably obtain high quality service by comparing service related expectations and perceptions.

2.4 Service quality and customer satisfaction

Oliver (1980) found that before consumers' buy certain products, expectations can be generated regarding those product, thus influencing buying inclinations. Moreover, the degree of satisfaction derived following buying can be influenced by the difference between the performance of the product bought and customer expectations before making the purchase. Consequently the degree of satisfaction can be considered the function of expectations followed by disconfirmation, and thus the "expectation-disconfirmation" theory was proposed. Additionally, in 1988, Oliver et al. performed an evidence study on customer satisfaction with vaccination decisions, and found that before making a purchase, customers form expectations regarding the product and the service, and if perceptions of the product or service fail to live up to expectations then disconfirmation occurs and impacts customer satisfaction [8].

The suggestions of scholars indicate that service quality and customer satisfaction have a supplementary relationship and have a positive cause and effect relationship. Service quality is the recognized method of evaluating service process and results. Customers that perceive service quality as excellent are satisfied, while other customers are dissatisfied. The ultimate goal of service quality is to satisfy the customer to further promote customer product buying intentions. Therefore, most scholars now define the concept of service quality as satisfying customer needs and increasing customer satisfaction.

3 Constructing a system dynamics model for information system service quality

3.1 System dynamics

System dynamics was first developed by Forrester, a professor of MIT, in 1956. System dynamics is based on the system analysis test method, decision-making theory, information feedback control theory and computer simulation technology, and focuses on studying dynamic complex systems that are "high level, non-linear and multi-loop". The book "Industrial Dynamics" by Forrester proposes that: the system dynamic mode can contain unlimited details of real process concepts which can be proposed using any language, and their interactive relationships, and can even represent the complex affected results of various consisted part of the system along with progress of time. The system view in system dynamics views the world as a cyclical interaction and being cause and result with each other, which involves numerous decision points and can cause certain activities to occur, thus changing the state and affecting new decisions, creating a cycle of cause and effect [4].

3.2 Fundamental elements of system dynamics

In 1980, Forrester posited the process of transforming a mental database into a written database and finally a numerical database involves reducing their content. Forrester considers mental databases to be constructed based on human observations and experience. Meanwhile, written databases, sourced from metal databases, provide a means of understanding system structure, and moreover provide a basis for establishing the system dynamic model since they are based on the description of actual practice. Finally, numerical databases employ specific numbers to describe the explained objects, such as parameters and time sequence data, and so on.

During model quantizing, the system dynamics approach uses a cause and effect feedback

diagram, dynamic flow diagram and equation to transform the mental model, and then describes the system model for expressing the concept of system dynamics. Therefore, the three kinds of diagrams represent the fundamental elements of the system dynamic model.

4 Individual element analysis for information system service quality

4.1 Four subsystem analysis
System dynamics focus on the key factors in the real system, and less important factors will be neglected, so the limitation and scope should be clearly defined. The service quality of the information system is mainly discussed in this study, namely the customer's satisfaction with the information system sources regarding conformity to schedule, budget and function [9]. Thus, the cause and effect relations of the elements affecting the customer's recognized service are discussed in regard to the roles of the "consultant", the "ERP system provider" and the "enterprise". According to the collected papers and the results from the study, the core elements related to the customer's recognized service are listed as shown Table 1.

Table 1   Related elements of the customer's recognized service

Roles	Elements
Consultant	Consultant instruction quality
ERP system provider	Customization extent System construction time System problem solving time
Enterprise (Customer)	Customer's expected service

(1) Consultant instruction quality
In the past, many scholars indicated that, among the elements for successfully introducing ERP, the ERP consultant is one of the key factors. Additionally, the ERP performance evaluation must be included training through consultant [3]. Yang et al (2004) suggested that examining the professional expertise of the consulting company is one of the critical ERP implementation items [11]. Bingi et al (1999):"the selection and coordination of the ERP consultant" is one of the key factors in introducing ERP [2].

(2) Customization extent
ERP is an information system for the core management, and therefore the requirements would inevitably be different for different industrial areas and different enterprises. March proposed for the first time in 1963: if the information system can meet the user's requirements, then the user's satisfaction with the information can be increased, or if it can not meet the user's requirements, then the satisfaction will be decreased. Bailey and Pearson's ERP satisfaction questionnaire incorporated the "customization treatment and amendment" into the question items [1].

(3) System construction time
Bailey and Pearson's ERP satisfaction questionnaire listed the "time for ERP system introduction" into the question items [1].

(4) System problem resolving time
The resulting system maintenance and amendments after the on line running of the system is naturally related to its duration. During both the introduction of the ERP process and the following maintenance stage, system problems will be inevitable. The problems may be programme mistakes, or simply due to user neglect. All problems need to be solved by personnel responsible for the system, or the operation may be frequently interrupted , which will affect the process procedure. Therefore, the time necessary to solve the problem will directly affect the customer's evaluation of the service.
By integrating the definitions and elements proposed by each scholar, the variable is called "system output quality" in this study.

4.2 Subsystem of consultant instruction quality
Figure 1 shows that, in the ERP introducing process, the consultant acts as a role of instruction and supervision fulfills both instruction and supervisory roles. Based on accumulated experience, consultants can provide an effective scheme which is productive and suitable for the enterprise, improving user perceptions of the service, and thus enhancing perceptions of information system service quality. Improving the service quality can help the propagation of public remarks and further increase the body of experience available as a basis for instructing customers. The "information consultant service quality" flow diagram considers the "project processing speed", "experience converting speed" and "valid project ratio" influence the "accepted project quantity",

"instruction experience" and "valid project", respectively. The circuit is a positive loop (R represents), indicating that the variation of the level is influenced by "project processing speed", "experience converting speed and effective project ratio". Furthermore, "information consultant service quality" is also influenced by the external variable "project control ability", "customer guiding extent", "industrial specialty knowledge. Meanwhile, the final summarized result can only affect the rate of increase of "customer recognized service" following a period of delay, thus changing the state of

"customer recognized service".

4.3 Customization extent subsystem

When information system service quality is improved, upper management will be more confident and have higher coordination intentions. Once the support of upper management is obtained, the chief of informatization will be asked to propel the ERP and actively complete the required work and the communication of the flow to achieve the function expected by the enterprise. This "customization extent" cause and effect loop is a positive one.
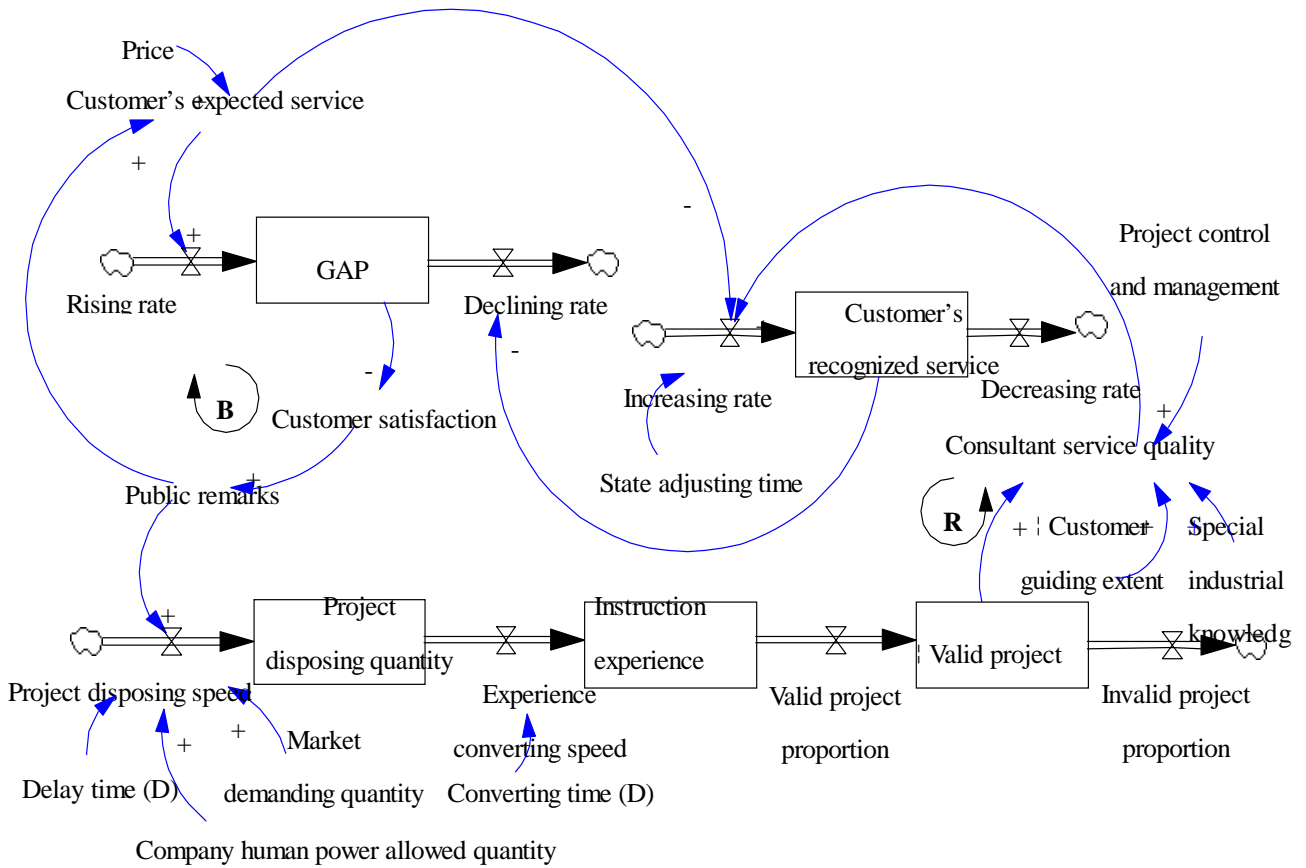

Figure 1 Flow diagram of the "consultant instruction quality" subsystem

4.4 System construction time

An effective communication mechanism can reduce the amendment frequency, help the effective implementation of the communication and coordination results and reduce the time required to introduce ERP. Additionally, the effective introduction scheme proposed by the ERP consultant and the speed of the ERP supplier in dealing with problems, can also

influence the time schedule of ERP introduction. "Time schedule progress increasing rate" is influenced by the "predicted progress delay" and "valid scheme", where the latter in turn is related to the rate in of the level "system establishment time". A positive loop exists. The "rate of increase in the delay" of the "predicted progress delay" is positively influenced by the "amendment frequency" and "work load".

4.5 Subsystem of system problem solving time

The total workload will increase in an increase in the business undertaken, as well the workload dispatched to the employer. Increasing accumulated workload will delay the disposal time for customer identified problems, increasing the time between the customer reflecting problems to the problem resolved; however, as the technical experience of the employer accumulating, the problem solving time can also be reduced. The diagram shows that the cause and effect loop diagram for the "problem disposing time" is a negative one (B represents). To ensure that the employer has the technical abilities necessary to drive continuous system improvement, the rate of "technology increasing rate", is affected by "accumulated employee training time"," number of experienced employees", "number of inputted high-tech human sources ", and "technology accumulation" can be accumulated.

5   Conclusion

In this study, by taking the ERP system as an example and targeting information system service quality. Taking ERP as an example and focusing on information system service quality, this study discusses the interaction of various factors in the service model recognized by the customer by incorporating the factors related to supplier and computer hardware, including schedule, quality and personnel, and so on, into the system as variables, from the view point of the three parties of the consultant, the ERP system supplier and the enterprise. Related with the four elements of "consultant instruction quality", "customization extent", "system construction tim" and "system problem solving time", a system dynamic analysis and study was performed discussing the significant influences on service quality, yielding the following conclusions:

a. The recognized service takes expected level of service as a target for balancing the system dynamic.

b. The improvement measures should be implemented from the intervention point of policy maintain system state adjustment function.

c. The "enterprise", "consultant" and "ERP supplier have a link-to-link relationship.

d. For the user's demands, the system amendment shall be performed following a comprehensive evaluation.

The adoption of a system perspective to discuss service quality provides another type of study method. For an information system, the influences on service quality are not entirely dependent on the service provider, and this study used the system dynamics perspective to incorporate the cause and effect relations between related factors and had identified an intimate relationship among factors. This work also examined the influence of factor variation on the state of the system from a dynamic perspective.

References:
[1]   Bailey JE. and Pearson SW, Development of a tool for measuring and analyzing computer user satisfaction, *Management Science*, 29, 1983, pp.530-545.
[2]   Bingi, P and Sharma MK and Godla JK, Critical issues affecting an ERP implementation, *Information System Management*, 16, 1999, pp.7-14.
[3]   Fisher DM, Fisher SA, Kiang MY and Chi RT, Evaluating mid-level ERP software, *Journal of Computer Information Systems*, 45, 2004, pp.38-46.
[4]   Forrester, JW, *Industrial Dynamics*, Cambridge, Mass: The M. I. T. Press, 1961.
[5]   Kip, RK and Win GJ, Reaping the promise of enterprise resource systems, *Strategic Finance*, Montvale, 2000, pp.48-52.
[6]   Laughlin, S, An ERP game plan, *The Journal of business strategy*, 20, 1999, pp.32-37.
[7]   Maskell, B, Integrated systems and how to implement them, *Management Accounting*, 1986, pp.26-28.
[8]   Oliver, RL, A cognitive model of the antecedent and consequences of satisfaction decisions, *Journal of Marketing Research*, 17, 1980, pp.460-469.
[9]   Olshavsky, RW, Perceived quality in consumer decision making an integrated theoretical perspective, Lexington, MA, Lexington Books, 1985.
[10] Wamcocks L, The role of the CIO and IT function in ERP, *Communication of the ACM*, 2000, pp.34-38.
[11] Yang CC, Lin WT, Lin MY and Huang JT, A study on applying FMEA to improving

ERP introduction: An example of semiconductor related industries in Taiwan, *International Journal of Quality & Reliability Management*, 23, 2006, pp.298-322.