A Competency-based Strategic Information System Planning System Development and Its Application

Choi, Sang Hyun[a] and Bae, Seong Moon[b]

Department of Industrial and Systems Engineering, Engineering Research Institute, Gyeongsang National University, 900 Gazwadong Jinju Gyeongnam, Korea 660-701

[a] Tel: +82-55-751-6215, Fax: +82-55-762-6599, E-mail: chois@gsnu.ac.kr

[b] Tel: 82-55-751-6221, Fax: +82-55-762-6599, E-mail: bsm@gsnu.ac.kr

Abstract

This paper presents a competency-based system for supporting corporate strategic information system planning. This system is implemented in practice via a detailed three stage methodology. The three stages are defining current business, analyzing competency, and suggesting To-Be enablers. The business objectives are evaluated on competencies in terms of experts' preference information about degree of importance between competencies on them. This system provides an efficient, systematic and structured framework and helps dramatically reduce the time needed to plan strategic information system.

1. Introduction

Improved strategic information system planning (SISP) is the most critical issue facing information systems executive today. Because the purpose of SISP is to identify the most appropriate targets for automation and to schedule their installation, SISP has the potential to make huge contributions to business and other organization. Effective SISP can help organizations use information systems to reach business goals, a major objective of senior executives. It can also enable organizations to use information systems to significantly impact their strategies. However, the failure to carefully carry out SISP can result both in lost opportunities and the waste of expensive information systems (IS) resources [4].

Pant and et al. [5] suggest a framework for Web-based information systems planning. The premise of their panning framework is that Web-based systems should be driven by the "push" view of information technology, which will substantially enhance their effectiveness and efficiency. The push view means that new information technology pushes the scope of the business and its strategy. This requires that the strategic planning methodology for WIS be grounded in a through understanding of the capabilities of the Internet and the Web technologies and their promise for effecting paradigm shifts for business. The methodology is suitable for the organization that creates profit and changes the business strategy through information technology. For the organization looking at IT from a costing aspect, it is desirable to consider IT as a supporting tool for business objectives. It is necessary to provide SISP personnel with the flexible system that suggests suitable IT according to importance rates of strategic objectives. It means that if we change the importance rate, different set of ITs has to be suggested. SISP tasks are usually periodic, repetitive but takes long time. Traditional frameworks are difficult to reflect rapid IT and business changes

Organizations generally apply one of a number of methodologies in order to perform these SISP. The popular methodologies include business systems planning [3], strategic systems planning, information engineering, method/1 [1], CSF [9], value chain analysis [7] and so on. Those methodologies are well classified and reviewed in [4]. The underlying motivation for our research is that we suggest the

ways that collect easily and aggregate effectively opinions of group members. In most organizations, SISP are made by group members who usually consider a set of organizational or technical aspects, but it is sometimes difficult to achieve a consensus among group members for such measure as IT priority and so on. Therefore, a decision supporting tool is needed to help group members to reach a consensus for the group decision making. In particular it is desirable to evaluate the IS levels of affiliated companies by the multiple attribute group decision making (MAGDM) methodology. Many companies evaluate the IS level with the organizational and operational viewpoints such as management strategy, IS management, resource management and so on. Those who are participate in the IS level evaluation process include top managers, middle managers, IS managers and real workers and have different viewpoint according to their positions.

In measuring a decision-maker's preference information about degree of importance between competencies on business objectives, getting a set of incomplete information is due to the fact that the decision-maker has a complete, exact preference structure but he/she does not want to properly communicate with the decision analyst. This can be the result of factors like: time pressure, the reluctance to use formal methods, unwillingness to have one's own opinion too open to criticism, or problems attached with the interrogation procedure. The imprecision of preference information, on one hand, may provide the decision-maker with opportunities that are enhanced freedom of choice and comforts of specification and, on the other hand, may cause decision-analysts difficulties in establishing dominance relations among IS alternatives.

2. A Framework for Competency-based SISP Support System (CoSIS)

The main idea of the proposed framework is to align business objectives with technical or organizational enablers through organizational competencies as shown in figure 1.

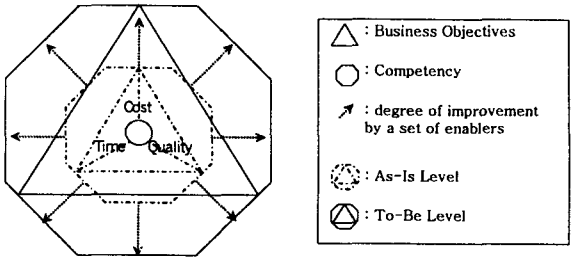

Figure 1. CoSIS Framework

The business objectives would be achieved by organization's competencies C_i, $i = 1,...,N$. This concept is based on a new six framework on the relationship between the role of IS and competencies in IS management suggested by Philip, Booth [6]. The competencies are classified into IT and process ones. IT competency is classified into IT management, IT architecture containing software, hardware, network and so on, organizational application, and information management, such as application data, information and knowledge. Process competency is related with an interconnected chain of primary activities, such as those involved with producing, selling, and servicing products, which are suggested by Porter and Millar [8]. It can be specified by the extended process such as product data management, customer relationship management, supply chain management and so on. The process competencies can be specified in various ways and are different by its product or industry. In our framework K participating SISP experts specify the competencies suitable to their organizational situations. For each industry there are lots of business enablers and technical enablers for securing the competencies. It is desirable for each company to select the enablers which are to enhance the values of business objectives. It is however very difficult to connect directly business objective and the enabler because there are so many enablers for each objective and so many associations between them. Then we put the competencies between objectives and enablers and evaluate the competencies based on objectives. Then the important competencies are extracted and used to find a set of enablers having close relations to them.

The enablers can be classified by relating

competencies and given by industry experts. Venkatraman [10] suggested a framework of IT-enabled business transformation, illustrated it with a wide array of examples, and derived implications and guidelines for management. The major categories of technical/organizational enablers and inhibitors were suggested at the levels. Based on two concepts we are going to suggest the enablers for competencies.

3. CoSIS Procedure

3.1 Mathematical problem definition for evaluating competency

In order to evaluate importances of competency in the viewpoint of business objectives, we utilize incomplete information based MAGDM methodology [2], which is applied to this problem because the analysis deals with situations in which decision alternatives, such as competencies, are evaluated on a finite number of attributes, such as business objectives. One of the best known and the most widely used ways to evaluate alternative $c = (c_1, \ldots, c_i, \ldots, c_N)$ is to utilize the weighted additive decomposition

$$v(c_i) = \sum_{o=1}^{M} w_o v_{oi}(c_i) \quad (1)$$

of a value function v. Here, v_{oi} is the marginal value function of objective o such that $v_{oi} : c_i \rightarrow [0, 1]$ and w_o is the importance rate of o-th objective which is given by the experts. If the decision parameters $v_{oi}(\cdot)$ are all exactly or numerically assessed by the expert group, finding the most important competencies is done by simple calculation using (1). In some practice, however, it is no simple matter to actually measure the exact values of competencies. Rather, the group members gives only certain linear relations which express imprecise information about the association relation between competencies on each objective. Examples of imprecise information are in the form of bounded descriptions; weak preference ($v_{oi} \geq v_{oj}$), strict preference ($v_{oi} - v_{oj} \geq \varepsilon$), preference with multiple ($v_{oi} \geq a_{ij} v_{oj}$), interval preference ($l_{oi} \leq v_{oi} \leq u_{oi}$) and preference difference ($v_{oi} - v_{oj} \leq v_{ol} - v_{om}$) [2].

3.2 CoSIS procedure

This framework is implemented in practice via a detailed three stage methodology. The three stages are defining current business, analyzing competency, and suggesting TBEs as shown in figure 2.

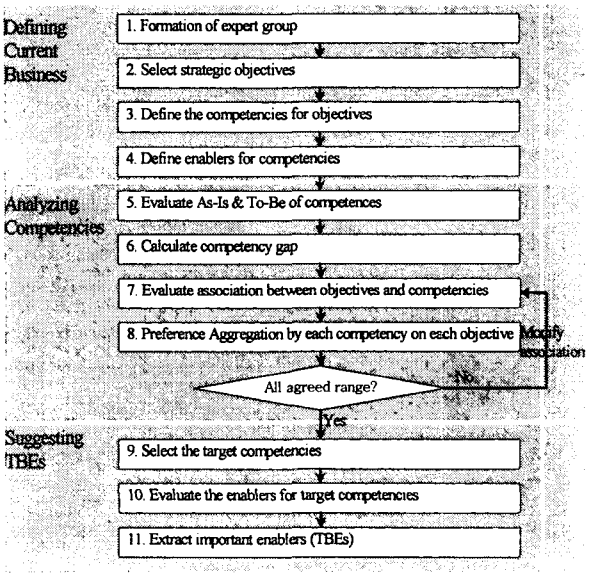

Figure 2. Three stages of CoSIS

Step 1. Defining current business

The first step is to identify the strategic directions of the target company. Firstly an expert group is composed of 3-4 top managers from internal organization and 2-3 external experts. Assume that we have gotten the weight of k-th expert as w^k, $k = 1, \ldots, K$. They refine strategic objectives as followings. The group selects an objective category by the industry related with the company, because the category is defined differently according to the industry. The group assigns importance rate, w_o, to o-th objective, where $\sum_o w_o = 1$, $0 \leq w_o \leq 1$ and o=1,...,O. And they define the competencies to be needed for attaining the above strategic objectives and IT elements to significantly impact their IT competencies. One of the SISP objectives is to recommend the most appropriate IT elements in support of the desired business improvements. They are associated with four IT competencies or process

competencies. The IT elements are suggested as To Be Enabler (TBEs) in a step 3.

Step 2. Analyzing Competencies

This step is to evaluate current status of the company in the viewpoint of competency and suggest competencies to be improved. The experts individually evaluate the current (As-Is) level and the desired (To-Be) level of the competences. Suppose the *k*-th group member gives *i*-th competency As-Is level, $v^k_{AS(c_i)}$, and To-Be level, $v^k_{TB(c_i)}$, with likert points from 1 to 5. The level descriptions for each point is pre-defined in the competency level library. After getting the level scores from all experts, aggregated As-Is and To-Be levels of the competences are computed by weighted sum of level scores as following formula (2),

$v_{AS(c_i)} = \Box_k w^k v^k_{AS(c_i)}$ and $v_{TB(c_i)} = \Box_k w^k v^k_{TB(c_i)}$ (2).

Then, we can calculate the competency gap between As-Is and To-Be levels by computing $v_{TB(c_i)}$-$v_{AS(c_i)}$. Next task is to evaluate the degree of association between strategic objectives and competencies. The group provides common opinion about association relationships between competencies within each objective. This task is performed based on five types of incomplete information. The modelbase about information types is used to get information about group members' preferences of importance relationships of competencies on each objective. The group enter the incomplete information as shown in figure 7.

Next, we calculate importance rates of competencies using the incomplete information. Using constraints about group's aggregated preferences of competencies obtained at the previous task, we calculate utility ranges of competencies. We define the association relationship set between competencies within each objective as $\Box_c$. We can get the utility range of *i*-th competency, $[v_{min}(c_i), v_{max}(c_i)]$, by following formula (3).

$v_{min}(c_i)$ = minimize $\Box_o w_o v_{oi}(c_i)$ subject to $\Box_c$ and

$v_{max}(c_i)$ = maximize $\Box_o w_o v_{oi}(c_i)$ subject to $\Box_c$ (3)

If the range of *i*-th competency exists, we have gotten the agreed range and go to step 3. Otherwise, the expert group has to refine the information of the association relationship set between competencies to get the agreed range.

Step 3. Suggesting To Be Enablers

Final step is to extract important To Be enablers (TBEs) based on values of gap and importance of competencies. We select the target competencies using Gap & Importance (GNI) matrix. We represent the competencies at the GNI matrix as shown in figure 8 using the gap values and importance rates calculated at step 2. The expert group defines thresholds of importance and gap, $\Box_1$ and $\Box_2$, respectively and select the target competencies having $P[v(c_i) > \Box_2] \Box 0.5$ or gap values equal to or larger than $\Box_1$. We will not consider the competencies that $P[v(c_i) > \Box_2]$ is less than 0.5 and gap value is less than $\Box_1$. We assume that importance distribution of *i*th competency are uniform between $v_{min}(c_i)$ and $v_{max}(c_i)$. Then $P[v(c_i) > \Box_2]$ is computed by $(v_{max}(c_i) - \Box_2) / (v_{max}(c_i) - v_{min}(c_i))$. Next task is to evaluate importance rates of the TBEs for the target competencies.

The group members assign importance rates by 3 scale measurement to corresponding IT elements on the competencies. The importance rate, $v^k_i(E_j)$ means a score *k*-th group member assigns to an element E_j in the viewpoint of *i*-th competency. The value of *j*-th element, $v(E_j)$ is calculated by $\Box_k w^k v^k_i(E_j)$. We can get the values by ranges, $[v_{min}(E_j), v_{max}(E_j)]$, because the importance rates of competencies are calculated by range values.

$v_{min}(E_j) = \Box_k \Box_i v_{min}(c_i)\ v^k_i(E_j)$

and $v_{max}(E_j) = \Box_k \Box_i v_{max}(c_i)\ v^k_i(E_j)$ (4)

Then we compute average values of the range by computing $(v_{min}(E_j) + v_{max}(E_j))/2$. Finally we select the J TBEs in the order of their average values.

4. CoSIS Architecture and Implementation

The architecture of CoSIS is depicted in figure 3. The system has four core functional managers for supporting SISP. The following is the detail description of each component.

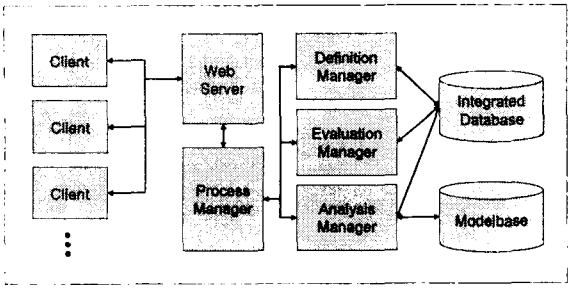

Figure 3. Architecture of CoSIS

The process manager is the main module of the system. It controls all the planning procedure described in the previous section and communicates with other functional managers - definition manager, evaluation manager and analysis manager. The definition manager performs the various definition tasks and sets up the configuration parameters such as acceptable competency gap and importance levels in the GNI matrix. The manager defines basic information of target company, strategic objectives, IT and process competencies, To Be enablers and the information of evaluation group members. The evaluation group is composed of internal and external experts of the related industry and evaluates the gap values and the importance rates of the competencies. The evaluation manager receives the evaluation results and stores them into the integrated database. The analysis manager computes the competency gap between As_Is level and To_Be level. It also calculates the importance range of each competency using the arithmetic algorithm stored in the modelbase.

The object diagram, depicted in figure 4, shows the core objects and the relationships between the objects using the standard UML notation. The detail descriptions of the major objects are as follows. The basic objects - *company, experts* - contain the overview of the target company and SISP experts. The *strategic_objective* object represents the objectives of the target company defined by the executives, and is composed of objective_id, name, category, weight and description. The *competency* object describes the core competency of the company and has two different types - *IT_competency* object and *process_competency* object. The main attributes of the object are competency_id, name, type and description. The *IT_element* object, related to *IT_competency* object, is an enabler for strategic action planning.

The objects involved in evaluation and analysis are *objective_&_competency_evaluation* object, *importance_evaluation* object, *As_Is_&_To_Be_evaluation* object, *gap_calculation* object, *importance_rate* object, and *target_TBE* object. The *objective_&_competency_evaluation* object and the *importance_evaluation* object calculate and store the importance values of the competencies based on the five types of incomplete information. The *As_Is_&_To_Be_evaluation* object evaluates the current and desired level of the competencies, and calculates the gap between the levels. The attributes of the object are competency_id, expert_id, As_Is_level, To_Be_level, and gap. The *importance_rate* object stores the importance value of target TBEs derived from the GNI matrix. The main attributes are IT_enabler_id, expert_id, target_competency_id and importance_value. The *target_TBE* object represents the SIS planning result and is an weighted sum of importance_rate of TBE.

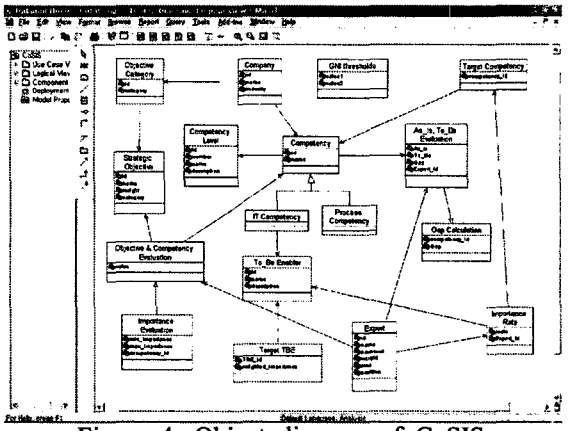
Figure 4. Object diagram of CoSIS

The CoSIS is implemented in the following software platform as shown in figure 5.

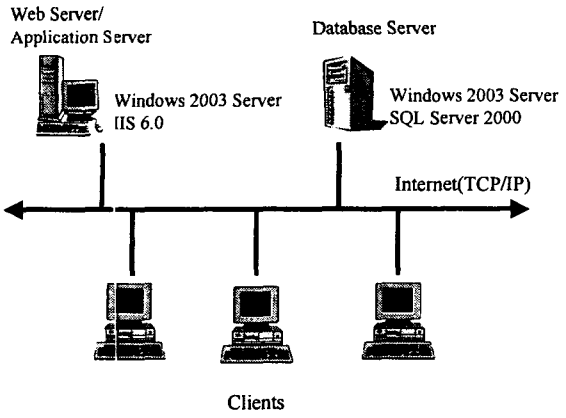

Figure 5. CoSIS platform

- Client: Any machine that can run a web browser
- Server OS platform: Windows server 2003
- Web server: Microsoft IIS 6.0
- Database: Microsoft SQL Server 2000
- Modeling Tool: Rational Rose
- Development Tool: Visual Studio .NET 2003
- Programming language: C#

5. Case Study

The selected organization in this case study is the customer service department of a Korean electronic company. Before this experiment, the SISP team including 3 managers and 3 consultants participated in this group decision process performed the manual SISP task using a consulting framework. The framework is very similar to one of CoSIS, but different with respect to information collection and evaluation methods and system support with libraries of business objectives, competencies and enablers. The group performed manually the task using same business objectives, competencies and enablers.

Step 1. Defining current business

Firstly a team manager selects the industry pertaining to the company, the number of employees and sales amounts. The system finds and suggests a standard definition of strategic objectives, competencies and IT elements from the industry definition library. Based on the information the team defines them. Figure 6 shows the result of current business definition step. The department are focusing on seven kinds of specific objectives within speed, cost and quality categories.

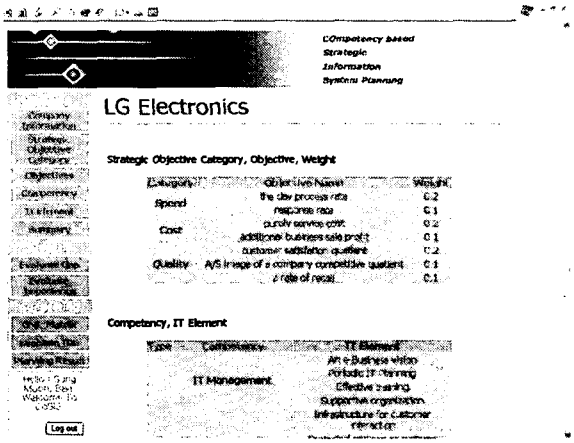

Figure 6. Summary of current business definition

Step 2. Analyzing competencies

In this step, the group members evaluate the current and desired levels of the competencies defined at the previous step. The competency gap values are calculated. And the group enters the agreed opinion about association relations between competencies within each objective as shown in figure 7. The left side of the input screen shows all association relation information according to objectives given by the group.

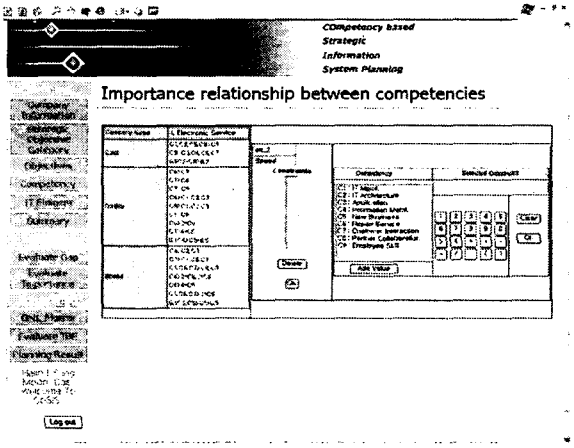

Figure 7. Input screen of importance relationship between competencies

The analysis manager calculates the importance ranges of competencies using formula (3) at section 3.2.

Step 3. Suggesting To Be Enablers

The group selects target competencies whose gap and importance values have more than thresholds. The group can see the values at the GNI matrix as shown in figure 8. The group pre-defined the gap and importance thresholds as 0.9 and 0.4. They selects 6 target competencies, IT architecture, application, information management, repair service, customer interaction and employee skill.

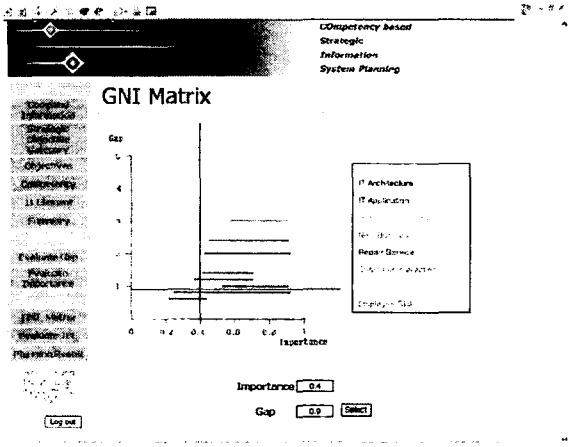

Figure 8. GNI matrix for competencies

Next, the group evaluates the importance rate of TBEs for the target competencies by 3 scale measurement such as H, M and L. Then the analysis manager calculates importance ranges of TBEs by the weighted sum of importance ranges of competencies and importances of TBEs on competencies.

Finally we can get total scores of TBEs select important TBEs in the order of their scores as shown in figure 9.

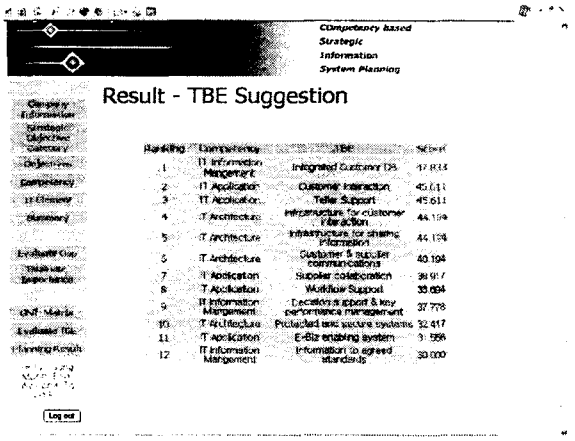

Figure 9. Final result of suggesting TBEs

We compared this result with one of the manual SISP task using a consulting framework. We selected 8 TBEs having most scores. In the viewpoint of suggested TBEs 'teller support system' and 'workflow support' were added and 'information to agreed standard', 'decision support & key performance management' were excluded and the rest of them were same in this framework.

6. Conclusion

The effective and efficient SISP requires three kinds of considerations. Firstly, it is necessary for the competitive company to drive the related IT elements or enablers according to the importance rates of its business objectives. Second one is to perform the planning in step with the change of industrial environment surrounding the company in order to extract suitable competencies to the relating industry. Third one is related with what kinds of information the company gets and how to aggregate the opinion from experts in the industry. To reflect those considerations we suggested a competency based framework for SISP to find TBEs based on importances of competencies. The framework is based on the concept of industry library in order to derive competencies and enablers to reflect situation surrounding the company. It is necessary for the company to revise the library according to trends of business and IT. For effective collection of expert opinion we used incomplete information about association relations between competencies on objectives and 3 scale measurement about importance rates of TBEs on competencies.

Based on the framework we have developed a system, CoSIS, to perform SISP. This system helps the SISP team to store real SISP cases or history and reuse the cases hereafter. The team can perform rapidly what if analysis such changes of importance rates as those of business objectives and between competencies on objectives and get different results according to the change of industry situation. This system applied to a department of electronic manufacturing company. It is necessary to extend

the reference library into other industries.

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