Organizational Knowledge Acquisition: A Fuzzy GSS Framework

Jae-Nam Lee*

조직의 지식 획득: 퍼지 GSS 프레임웍

이 재 남*

Abstract

Although the concept of viewing knowledge as a critical resource has been widely accepted in prior studies, it is not fully understood how to acquire available knowledge in order to improve organizational effectiveness. However, it is sure that organizational knowledge management should pursuit the achievement of the business goal by delivering relevant and useful information to the right person at the right time. Group Support System (GSS) can play an important role to transfer scatter information into meaningful business knowledge for supporting strategic corporate decision-making. This study proposes a fuzzy GSS framework for acquiring workgroup knowledge from individual memory and aggregating workgroup knowledge to organizational knowledge. This study also proposes an architecture to support the fuzzy GSS framework. The architecture consists of user agents, information management agents, and a fuzzy model manager. To illustrate how the fuzzy GSS framework can be used to support the whole process of organization knowledge acquisition, an Internet-based GSS was developed and applied in a marketing decision process. It showed that the framework was effective for acquiring organizational knowledge.

Keywords: Fuzzy Decision Model, Group support system, Knowledge acquisition, Organizational learning

1. Introduction

In order to response to new challenges in the rapidly changing external environment, modern management requires to use knowledge from various sources. Depending on the particular problem being investigated, organizational managers should switch between different perspectives and levels of detail when searching for the relevant pieces of knowledge required to provide an appropriate answer. However, managers' access to organizational knowledge is limited to a relatively small subset of the collective organizational knowledge depending on their situations and functions within the organization. This phenomena results from the lack of a centralized knowledge management facility. This leads to the inhibition of the interactions and interdependencies relevant to the problem among departments. To find more suitable organizational knowledge under a particular

* 한국과학기술원 테크노경영대학원, 연구원

situation, organizational managers should have a global organizational perspective instead of individual or workgroup perspectives.

Although the concept of viewing knowledge as a critical resource has been widely accepted in prior studies, it is not fully understood how to acquire available knowledge in order to improve organizational effectiveness. However, it is sure that organizational knowledge management should pursuit the achievement of the business goal by delivering relevant and useful information to the right person at the right time. Group Support System (GSS) can play an important role to transfer scatter information into meaningful business knowledge for supporting strategic corporate decision-making. GSS is an interactive computer-based system that combines computing, communication, and decision technologies to facilitate problem formulation and solution in collaborative work [4]. The goal of GSS is to ease the cognitive load of groups on particular decision making tasks so as to improve the productivity, efficiency and effectiveness of group meeting.

In this study, we propose a fuzzy GSS framework to define and acquire organizational knowledge from individual or workgroup memories. While individual knowledge can be defined as individual's justified beliefs for solving organizational problems, organizational knowledge is a collection of individual knowledge for organizational problem solving activities [13]. Since knowledge is inherently created and owned by individuals [3], the focus of organizational knowledge management is on how to collect individual's knowledge and aggregate them into organizational knowledge. However, there are no criteria how to discover organizational knowledge from various sources. Because many enterprise scenarios are too complex to be fully understood, the proposed model here are proposed to help decision-makers analyze specific situations by introducing workgroup and organizational preference about the existing information.

Organizations have become more and more distributed with information sources virtual and dispersed in many locations, which make it more difficult for a decision-making process to take an enterprise-wide perspective. Thus, organizations want to find a way to integrate information across the enterprise. The recent widespread use of World Wide Web (WWW) makes it possible to develop a knowledge centric enterprise-wide decision support system in a functionally decentralized company. Among the WWW technologies, we adopt the Internet-based GSS as a simple communication vehicle or a cutting-edged decision support network wiring the related decision units. The unique characteristics of the Internet are accessibility and information sharability among concerned units and people. Therefore, the Internet-based GSS for organizational knowledge acquisition is expected to facilitate the exchange of relevant information between concerned organizational units in a functionally decentralized company.

The objective of this study is to provide deeper understanding for organizational knowledge conversion process, especially knowledge acquisition process. To do so, we first propose a fuzzy GSS framework which consists of a GSS and a fuzzy decision model. Second, we develop an Internet-based GSS to show how the fuzzy framework can be used in enhancing the firm's ability to manage knowledge acquisition and knowledge aggregation processes. It is to provide a flexible approach to support the whole process of organizational knowledge acquisition, and leads to a high degree of organizational consensus regarding to the organizational preferences under a specific situation.

2. Organizational Learning

Organizational learning has been studied and defined

for a long time by numerous researchers. Organizational learning is defined as "increasing an organization's capacity to take effective action" [14]. According to Argyris and Schon [1], a process of error detection and correction constitutes organizational learning and is categorized into two types: single-loop learning and double-loop learning. Single-loop learning consists of a single feedback loop which compares expected to real outcomes so as to keep organizational performance stable within a range set by organizational norms. It is concerned with effectiveness in achieving existing goals and how to keep the organizational performance within the bounds specified by these existing norms.

The recent research of organizational learning is related to knowledge sharing (including knowledge creation, acquisition, and transfer) or behavior change [9, 11]. According to Garvin [9], he divided organizational learning into two phases: knowledge sharing and behavior change. Knowledge sharing phase involves the creation of knowledge, the acquisition of knowledge, and the transfer of knowledge among organizational members that enables them to enhance organization's efficiency, and emphasizes the understanding of an existing organizational context. Through knowledge sharing, organizational members can extend their thinking scope to the overall organization beyond their own boundary. Behavior change phase involves the modification of behaviors among organizational members to enhance organization's effectiveness, and emphasizes the significant organizational restructuring. Based on the transferred knowledge and changed ways of thinking, an organization can create a new type of knowledge on how to change its behavior.

To share knowledge effectively, organizations need the means to retain and transmit information from past to future members. This capability we might call the organization's memory. According to Walsh and Ungson [20], organizational memory is defined as "stored information from an organization's history that can be brought to bear on present actions". When organizational members participate in collaborative activities, they can disagree on a wide range of issues due to differences in goals, the information available, the understanding of the task, and multiple cognitive perspective on the problem [19]. Successful collaborative activities require a co-evolution of individual understanding of the participants and the shared understanding of the group. Therefore, it is essential to explore mechanisms to manage conflicts so that relevant information can be captured in organizational memory to facilitate shared understanding.

Many researchers have described several models of organizational learning even if no models cover all contingencies and are applied to all organizational environments. March and Olsen [16] made a distinction between individual and organizational action in their model. Individual actions are based on certain individual beliefs. These actions, in turn, lead to organizational action, which produces some environmental response. The cycle is completed when the environmental response affects individual beliefs. Daft and Weick [2] proposed a model that represents the overall learning process of an organization: scanning, interpretation, and learning. While scanning involves monitoring and obtaining data about the environment, interpretation is the process of translating events and developing concepts consistent with prior understanding of the environment. Learning is knowledge about the interrelationship between the organization's actions and the environment as well as the actions that are taken on the basis of such knowledge. Organizational interpretation is analogous to learning a new skill by an individual. The act of learning also provides new data for interpretation. Feedback from organizational actions may provide new collective insights for coalition members. Thus the three stages are interconnected through a

feedback loop. Kim [14] also proposed an integrated model of organizational learning called the OADI-SMM (Observe, Assess, Design, Implement - Shared Mental Model) cycle. It addresses the issue of the transfer of learning through the exchange of individual and shared mental models. Kim substituted "individual beliefs" in March and Olsen's [16] model with the OADI-IMM (Individual Mental Model) cycle of individual learning. This model also incorporates Argyris and Schon's [1] concept of single-loop and double-loop learning on both the individual and organizational levels. Although Kim provided an integrated model of organizational learning based on the previous literature, he did not consider workgroup learning and its mental model as a component in his model.

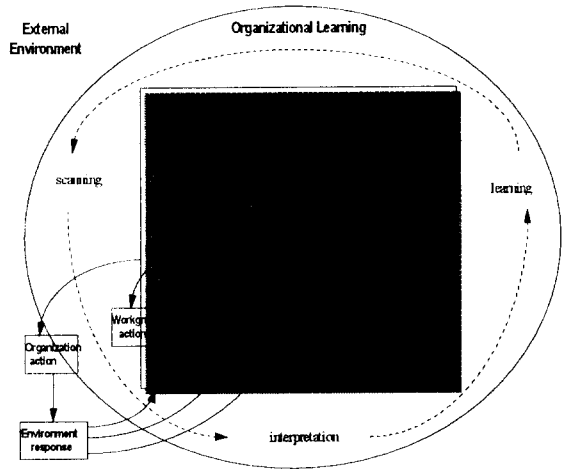

Figure 1. A conceptual model of org. learning

In this study, to cover all contingencies and organizational environments, we propose a conceptual framework of organizational learning. This framework includes individual, workgroup, and organizational learning as in figure 1.

Each learning area consists of three steps for learning: scanning, interpretation and learning as in Daft and Weich [2]'s model. The three steps affect their memories and in turn lead to their actions, while environmental response produced by organizational action affects organizational, workgroup and individual memories. Based on March and Olsen [16]'s model, our conceptual model of organizational learning focuses on the crucial link both between individual learning and workgroup learning, and between workgroup learning and organizational learning. Our model aims to differentiate between levels of learning, and specify the transfer mechanism among three levels of learning. Individual learning becomes embedded in a workgroup's memory and workgroup learning becomes embedded in an organization memory. It may provide a clear understanding of knowledge transfer process within an organization.

3. Org. Knowledge Conversion Process

Knowledge management is a process of capturing, storing, sharing, and leveraging knowledge [3]. Both the tacit and explicit knowledge are created and shared through the 'self-transcendental processes' [17]. Therefore, organizational knowledge management should be viewed as a process under a particular business. The process of organizational knowledge management can be triggered by business problems or events [12]. To solve them, organization's decision makers will inquire and search related information, data, or knowledge, sometimes seeking experts for ideas or suggestions. The human activities such as interpretation, understanding, analyzing, and reflecting will be very active during the process. However, individual's ideas or opinions can be shared among organizational members until they are validated organization-wide. Therefore, the decision-makers will try to justify their ideas, opinions, or information. After organization members validate the new ideas or opinions into knowledge, the organization can apply the knowledge on its process or product. The levels of organization's

knowledge can be analyzed in three dimensions such as individual, workgroup, and organizational:

- Individual: the individual knowledge worker is the fundamental unit for knowledge creation, storage, and use within an organization.
- Workgroup: networks, both formal and informal, are usually an intangible, but important knowledge asset with in an organization. Groups of individuals often represent a cumulative knowledge asset that is more than the sum of their individual skills, and can produce results of true competitive significance.
- Organizational: the entire organization with its own peculiar structures, division of functions, and processes can be viewed as embodying the result of a certain cumulative body of knowledge. The organization is designed to facilitate and direct knowledge flows, and evolves with changing knowledge needs

Based on the three dimensions, figure 2 shows how an organizational knowledge is created, shared, and finally transferred to organizational outputs, product or services. Learning and knowledge creation will occur through the whole process. Some ideas or opinions can be used as raw materials to create and acquire knowledge in an organization.

4. Fuzzy GSS Framework

Based on the organizational knowledge conversion process as in figure 2, we propose a fuzzy GSS framework for managing the whole conversion process. The framework includes a GSS for facilitating knowledge creation and sharing, and a fuzzy multi-criteria decision model for aggregating workgroup and organizational preferences.

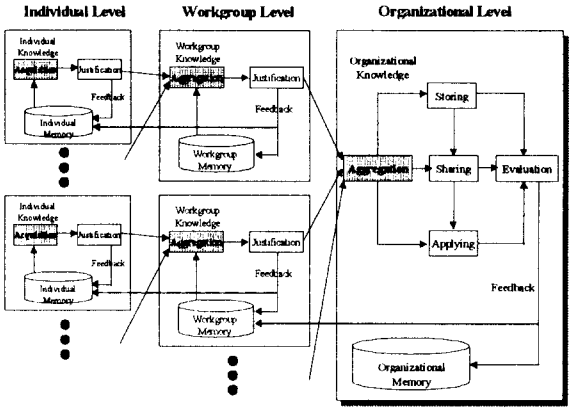

Figure 2. Organizational knowledge conversion process

4.1. Group Support System (GSS)

The whole organizational knowledge conversion process involves group processes where a group of individuals work together to accomplish a task of discussion, negotiation, and decision making. GSS is expected to make conversion process more effective, especially in a large group setting [5]. The literature [4, 6] suggests that GSS enhance group process by increasing group process gains and/or reducing group process losses. The effects of GSS on group process gains/losses contribute to the three attributes of knowledge acquisition, i.e. active engagement, co-operation and decision making [15].

In GSS-Supported environment, participants are encouraged to become more active, autonomous and confident in generating, exchanging, and analysing information and ideas when constructing the evaluation scheme. As it is difficult to preclude others from contributing ideas in an anonymous GSS environment, the domination of the meeting by one or only a few participants can be reduced [5]. Participants are not intimidated and are less inhibited [8]. Also, free riding can be diminished, as participants can contribute simultaneously and no longer need to compete for air time.

Furthermore, GSS enhances effectiveness of organizational learning by encouraging participants to support each other for information sharing, idea generation and decision making in formulating the organizational preferences. GSS also encourages the participants to provide feedback so as to assist them better understand the decision making task. Through information sharing and objective evaluation, it reduces individual domination, meeting time fragmentation and fear of reprisal [6, 8]. It also improves positive interpersonal communications and relationships amongst participants.

Finally, GSS helps the participants perform a deep analysis of the organizational problem, resulting in a better understanding of the organizational preference. In addition, an anonymous GSS environment encourages error catching in problem analysis [8].

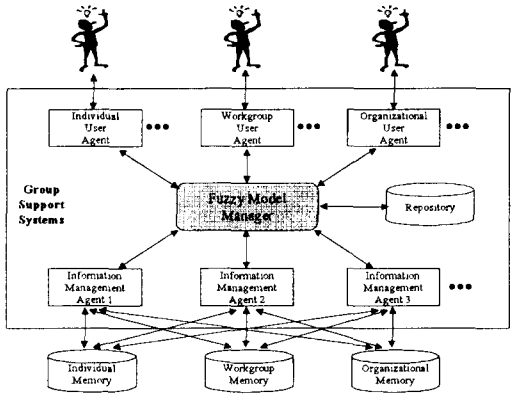

Figure 3. The architecture of the Internet-based GSS

To support the whole process of organizational knowledge acquisition previously mentioned, we have developed a partial prototype GSS based on an architecture framework as in figure 3. The GSS provides the following functions: brainstorming, voting and weighting. The system also supports anonymity in order to enable group members to voice their opinion freely without fearing a direct confrontation with the other members. With the tool, participants can type their ideas simultaneously into a network of computer workstations. The tool immediately makes all these contributions available for other members to read on their individual screens.

There are three classes of intelligent agents contained within this GSS architecture: *User agents* that act as the intelligent interface agents between the decision makers and the fuzzy decision model, *a fuzzy model manager* with repository that provides management and system coordination control functions over all the agents in the architecture, and *information management agents* that acquire new knowledge from individual and workgroup memories. In the architecture, the repository provides not only the means for the common vocabulary but also management for all schema evolution transactions. Using the repository, information relevant to the management, evolution, operation and maintenance of the Internet-based GSS can be shared in a transparent fashion.

Because information generated in a company is generally dispersed, we have chosen a distributed environment, the World Wide Web, for the implementation. The reason of using the WWW as the implementation platform is its capability for seamless information sharing and information integration. In a real world application, one would move the system to an Intranet environment to ensure data security. The concept of a centralized knowledge base, which keeps every piece of information generated in the company in one place, is not practical. Therefore, the organizational knowledge base should be decentralized at each department maintaining their own department specific knowledge. As in figure 3, each user is a Web client that has a Web browser. Individual, workgroup and organizational memories are located at Web servers that are maintained by different functional departments in an organization. The fuzzy model manager serves as the intermediary between user agents and information management agents that access scattered departmental servers.

More specifically, the prototype system was developed using a Windows NT server, SQL server, Internet Information Server (IIS) and Internet Database Connector (IDC) on a N-tier client-server architecture. The architecture also allows decision makers to access the system through an Internet browser (e.g., Netscape, Internet Explorer). For system portability, the system uses Open DataBase Connectivity (ODBC) with the IDC to send and retrieve information from SQL server. Thus, it makes the system easy to transfer to other RDBMS-based platforms.

4.2. The Fuzzy Multi-Criteria Decision Model

Much of the decision making in the real world takes places in an organization in which the objects, the limitations and the outcomes of possible actions are not known precisely. Fuzzy set theory has been developed to solve such decision making problems in which descriptions of observations are imprecise, vague, and uncertain [21].

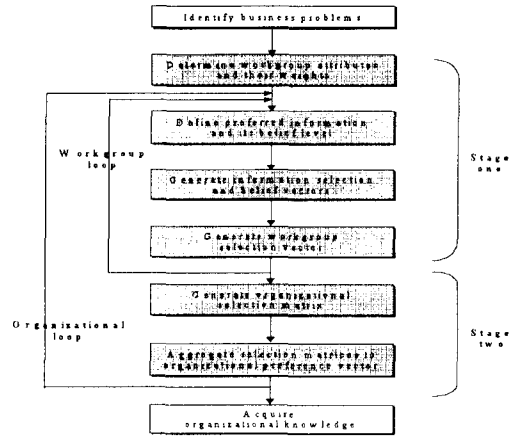

Figure 4. The procedure of the fuzzy decision model

In this paper, the fuzzy multi-criteria decision model for acquiring knowledge combines the ideas of non-ranked voting methods, particularly the approval voting method, with the fuzzy set theory [7]. It aims at providing a unified approach to support the whole process of organizational knowledge acquisition, and enhancing organizational consensus regarding to the organizational preferences under certain situation. The fuzzy model includes two stages: fuzzy workgroup knowledge acquisition and organizational knowledge aggregation. Figure 4 shows the overall procedure of the fuzzy decision model.

To provide clear understanding of the proposed fuzzy decision model, a hypothetical example and its application are presented, based on Kwok et al. [15], to illustrate how the above model can be used. We apply our model to a marketing decision process, which involves three marketing managers ($D=\{D_1, D_2, D_3\}$) in a marketing division who need to select their promotion types for their products. Since marketing planning decision for products is usually based on the characteristics of target customers, we assume that the company has a sales database storing information about any sales transaction. The marketing department also maintains marketing-related information gathered from the previous marketing promotion. The objective of the marketing decision process is to find what is the appropriate knowledge among the existing information for new market segmentation. Suppose there are five customer information in a marketing division need to be ranked ($I=\{I_1, I_2, I_3, I_4, I_5\}$). The attributes set for the market segmentation is $A=\{$buying pattern: A_1, occupation: A_2, salary: $A_3\}$.

4.2.1. 1st Stage: Workgroup Knowledge Acquisition

Following is the workgroup knowledge acquisition process for the first decision maker $D1$.

Step 1: By pairwise comparison of the relative importance of the workgroup attributes, the pairwise comparison matrix $E=(e_{ij})$ is established as below.

$$E = \begin{bmatrix} 1 & 1 & 1/3 \\ 1 & 1 & 1/3 \\ 3 & 3 & 1 \end{bmatrix}$$

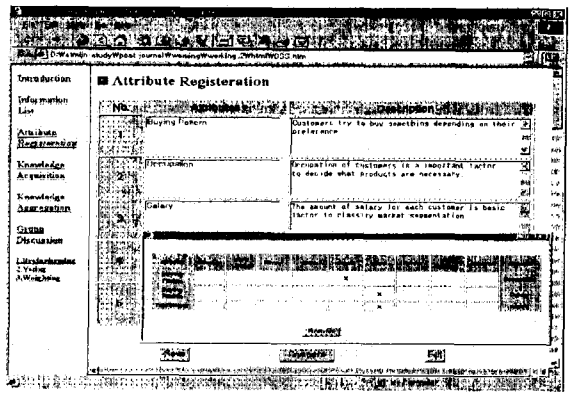

Figure 5. Interface window for workgroup attributes

The element of the matrix e_{ij} represents the relative importance of workgroup attribute A_i over attribute A_j [18]. For instance, the first row of the matrix means buying pattern is equally important as itself, buying pattern is equally important as occupation, salary is weakly more important than buying pattern. By calculating the normalized principal eigenvector of the matrix, the attribute weights, W = (0.2, 0.2, 0.6), is got. Figure 5 shows the interface window to register workgroup attributes and to establish the relative importance of the workgroup attributes.

Step 2: Against every workgroup attribute A_1, A_2, A_3, assign 1 to preferred customer information and 0 to undesired customer information. Meanwhile, assign belief level to the preferred customer information. The belief levels belong to the set of linguistic terms that contains various degrees of preference required by the decision makers. Linguistic terms are words or sentences in natural or artificial languages. For example, "very low", "low", "medium", "high", "very high" are linguistic terms. Linguistic terms are ill-defined and can hardly be described by single numerical values. In this study, we use linguistic terms Z (Belief) = {very sure, sure, not very sure, not sure}. The selection matrix (*vij*) and belief matrix (*bij*) are obtained (i=1, ..., t; j=1, ... ,m) as below.

$$(v_{ij}) = \begin{bmatrix} 1 & 1 & 0 & 0 & 1 \\ 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 \end{bmatrix}$$

$$(b_{ij}) = \begin{bmatrix} verysure & verysure & 0 & 0 & sure \\ verysure & 0 & verysure & sure & 0 \\ 0 & sure & 0 & notverysure & 0 \end{bmatrix}$$

A decision maker can use knowledge judgement window in figure 6 to choose or reject information depending on his judgement.

Step 3: According to equation (1), the information selection matrix (*vij*) is aggregated to information selection vector (v_j').

$$v_j' = w_1 * v_{1j} + w_2 * v_{2j} + \ldots + w_t * v_{tj} \qquad (1)$$

The result of information selection vector is as below. The decision maker can find this result in fig. 8.

(v_j') = (0.4, 0.8, 0.2, 0.8, 0.2)

Step 4: According to equation (2), the belief matrix (*bij*) is aggregated to belief vector (b_j') where the method for aggregation is similar to Baas and Kwakernaak (1977). The decision maker can inquire this result in the interface window for knowledge management in fig. 8.

$$b_j' = w_1 \bullet b_{1j} \oplus w_2 \bullet b_{2j} \oplus \ldots \oplus w_t \bullet b_{tj} \qquad (2)$$

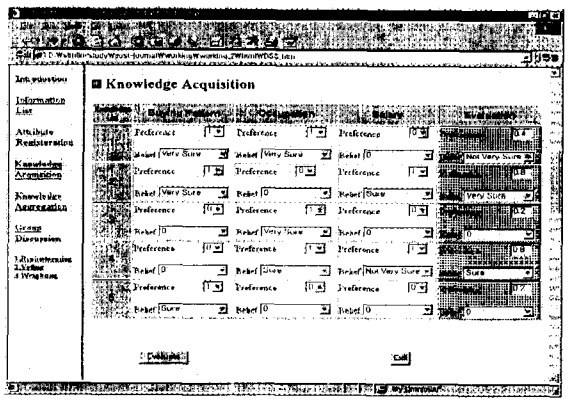

Figure 6. Interface window for knowledge judgement

Step 5: According to the values of vectors (v_j') and (b_j'), the decision maker *D1* again makes overall judgment on the customer information. The workgroup selection vector is (not very sure, very sure, 0, sure, 0).

4.2.2. 2nd Stage: Org. Knowledge Aggregation

Combining other two decision makers' workgroup preferences, organizational selection matrix ($b^g ij$) is obtained.

$$(b_{ij}^{g}) = \begin{bmatrix} not\ very\ sure & very\ sure & 0 & sure & 0 \\ sure & sure & not\ very\ sure & very\ sure & 0 \\ very\ sure & very\ sure & sure & 0 & sure \end{bmatrix}$$

Step 1: Similar to the step 4 of the first stage, the organizational selection matrix ($b^g ij$) are aggregated to organizational selection vector (r_j) (j = 1, 2, ... , m). The weights of decision makers are same, and each equal to $1/n$.

Step 2: Ranking the organizational preference vector, the result is as below. Figure 7 shows the final result of organizational judgement.

$$I_2 > I_1 > I_4 > I_3 > I_5$$

By ranking the organizational preference vector (r_j), the organizational decision group can select the top several information. As a result, the selected customer information, which is an agreed final organizational decision, can be considered as organizational knowledge in an organization.

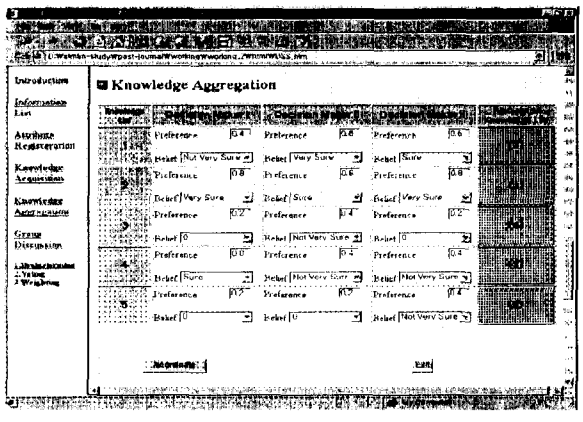

Figure 7. The result of org. knowledge aggregation

5. Conclusion

Learning emerges through a shared understanding of individuals with the assumption that individuals have knowledge to share with one another. The active contribution of different understandings from individuals leads to a new and shared knowledge established in an organization [15]. Knowledge is acquired by individuals as it is shared. At the same time, the shared workgroup knowledge grows as this loop of individual knowledge acquisition continues. This process of workgroup knowledge acquisition is initiated by the creation of collective memory which refers to the social process of articulating, exchanging, and sharing knowledge [10].

This paper proposes a fuzzy GSS framework for acquiring workgroup knowledge from individual memory and aggregating workgroup knowledge to organizational knowledge. The framework includes a GSS and fuzzy multi-criteria decision model. The role of GSS is to facilitate sharing and aggregating individual scatter information into meaningful organizational knowledge, while the fuzzy decision model is to enhance consensus to the organizational knowledge. The fuzzy decision model includes fuzzy workgroup preference generation and organizational knowledge aggregation.

This paper also proposes an architecture to support the fuzzy GSS framework. It consists of user agents, information management agents, and a fuzzy model manager. Based on the architecture, an internet-based GSS was developed and used in a marketing decision process. The results indicated that the fuzzy GSS framework was effective for organizational knowledge acquisition.

This study has the following limitations. First, the effectiveness of the proposed framework should be validated with enough cases or examples. Second, the basic assumption of the framework is that organizational knowledge is changeable according to business conditions, but some knowledge such as theory, principle, or pattern may not be affected by organizational context. As a future work, we can consider technology-based approaches to strengthen the fuzzy GSS framework. This study mainly focuses on the process of organizational knowledge aggregation rather than its supporting technologies such as

intelligent agent or data mining, the potential of this fuzzy GSS framework remains to be investigated.

References

[1] Argyris, C., and Schon, D. A., *Organizational learning: A theory of action perspective*, Addison-Wesley Publishing Company, 1978.

[2] Daft, R. L., and Weick, K. E., "Toward a model of organizations as interpretation systems," *Academy of Management Review*, 9 (2), 1984, 284-295.

[3] Davenport, T. H., and Prusak, L., *Working knowledge*, Harvard Business School Press, Boston, 1998.

[4] DeSanctis, G., and Gallupe, R. B., "A foundation for the study of group support systems," *Management Science*, 33 (5), 1987, 589-609.

[5] Dennis, A. R., "Electronic support for large groups," *Journal of Organizational Computing*, 4 (2), 1994, 177-197.

[6] Dennis, A. R., George, J. F., Jessup, L. M., Nunamaker, J. F., and Vogel, D. R., "Information technology to support electronic meetings," *MIS Quarterly*, 12, 1988, 591-624.

[7] Fedrizz, M., Kacprzyk, J., and Zadrozny, S., "An interactive multi-user decision support system for consensus reaching processes using fuzzy logic with linguistic quantifiers," *Decision Support Systems*, 4, 1988, 313-327.

[8] Gallupe, R. B., Dennis, A. R., Cooper, W. H., Valacich, J. S., Bastianutti, L. M., and Nunamaker, J. F., "Electronic brainstorming and group size," *Academy of Management Journal*, 35, 1992, 350-369.

[9] Garvin, D. A., "Building a learning organization," *Harvard Business Review*, July-August, 1993, 78-91.

[10] Halbwachs, M. *The collective memory*, In F.J. Ditter, V.Y Ditter (eds.) Harper Colophon, New York, 1980

[11] Huber, G., "Organizational learning: The contributing processes and the literatures," *Organization Science*, 2, 1991, 88-115.

[12] Johannessen, J. A., Olson B., and Olaisen, J., "Aspects of innovation theory based on knowledge-management," *International Journal of Information Management*, 19, 1999, 121-139.

[13] Kim, B. W., "Manufacturing learning propensity in operations improvement," *Human Factors and Ergonomics in Manufacturing*, 8 (1), 1998, 79-104.

[14] Kim, D. H., "The link between individual and organizational learning," *Sloan Management Review*, Fall, 1993, 37-50.

[15] Kwok, C. W. R., and Khalifa, M., "Effect of GSS on knowledge acquisition," *Information & Management*, 34, 1998, 307-315.

[16] March, J. G., and Olsen, J. P., "The uncertainty of the past: Organizational learning under ambiguity," *European Journal of Political Research*, 3, 1975, 147-171.

[17] Nonaka, I., and Konno, N., "The concept of 'Ba': Building a foundation for knowledge creation," *California Management Review*, 40 (3), 1998, 40-54.

[18] Satty, T. L., *Foundation of decision making and priority theory with the analytic hierarchy process*, RWS Publication, 1994

[19] Thomas, K., "Conflict and negotiation processes in organizations," *Handbook of Industrial and Organizational Psychology*, Dunnette, M.D., and Hough, L. (eds.), Palo Alto, CA: Consulting Psychologists Press, 1992, 651-718.

[20] Walsh, J. P., and Ungson, G. R., "Organizational memory," *Academy of Management Review*, 16 (1), 1991, 57-91.

[21] Zadeh, L. A., "Fuzzy sets," *Information and Control*, 8, 1965, 338-353.