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Abstract

Organizational decision-making is a complicated process with multiple stages and multiple groups of decision-makers. Different types of technology have been applied to facilitate the process and make it feasible at any time and any place. Nowadays, the Web technology provides a good infrastructure for this purpose. This paper presents a framework for Web-based organizational decision support. The framework consists of a conceptual model and the corresponding software architecture for support systems. It is then applied to the implementation of an organizational decision support system for Research and Development (R&D) project selection, which is one of the most important tasks for organizations with R&D project management.

Introduction

Organizational decisions are decisions made on the behalf of the organizations (Huber 1981). They form one of the most common routines in organizations. Examples of organizational decisions include public policy making, business strategy planning, project selection, contract negotiation, jury trial and so on. Organizational decisions differ from other types of decisions (e.g., personal or group decisions) in their organization-level purposes, organization-wide impact, multiple groups of participants, and heavy coordination tasks. An organizational decision is usually complicated and difficult due to the following reasons. First, it has multiple stages. Second, multiple decision-makers involved are usually geographically dispersed. Third, it may across the boundaries of the organization and involve decision-makers and information from outside of the organization. Finally, coordination efforts among the decision-makers are necessary.

The primary goal of organizational decision support systems (ODSSs) is to facilitate the organizational decision-making process with information technology. A considerable amount of effort has been made in literature. However, due to technology limitations in the past, research work from existing literature does not enable organizations to make decisions at any time and any place. For example, traditional client-server system architecture makes it difficult to make organizational decision-making at any place due to the requirement of specific client-end software. However, the problem can be solved nowadays by the Web technology which provides a unified client-end software. In addition, the browser-server architecture also provides a possibility to make organizational decision-making work without timing and location problems. The aim of this paper is to propose a Web-based decision support framework for organizational decision-making, which consists of a conceptual model and the corresponding software system architecture. The framework has been applied in an Internet-based information system for R&D project selection in the National Natural Foundation of Science (NSFC).

In the following sections, we first review the literature about organizational decision support systems in Section 2. Then in section 3, a conceptual model for organizational decision-making process will be presented. After that, we proposed a software architecture for the conceptual model in Section 4. And in Section 5, the application of the framework will be reported. Finally, a brief conclusion is arrived in the last section.

Review of Organizational Decision Support

Research on organizational decision support systems is driven by three forces: (1) the requirements to support organization change; (2) the advancements of information technologies; and (3) the knowledge accumulations in personal DSSs and GDSSs. Much research work has been done since such terms were introduced by Philippakis and Green (1988). Existing literature falls into three categories: conceptualization, architecture, and development.

The conceptualization aims to lay down a conceptual foundation which differentiates ODSSs from other decision support systems. Different ODSS definitions could be found in literature with different emphasizes on the provision of more support to some features of organizational decision-making. For example, Watson (1990) defines an ODSS as a system to support cross-functional decision processes to achieve organizational goals using computer and communication technologies. Swanson (1992) interprets an ODSS as a system to support the distributed decision-making across the organization. While Fedorowicz and Konsynski (1992) treat ODSSs as the information technology infrastructure of organizations supporting both decision and business processes, George (1991-1992) declares that the focus of an ODSS is to support decision activities that effect several organizational units. Generally, we may interpret ODSSs as a new class of decision support systems focusing on the organizational-wide rather than individual, group, or departmental issues. The differences between ODSSs and personal DSSs and GDSSs have been summarized in (Kim et al. 1997). Specifically, compared with personal DSSs and GDSSs, ODDSs have their unique decision scopes, decision makers, and technology components. While personal DSSs and GDSSs focus on individual- and group-level decision support, ODSSs put the emphasis on organizational-wide decisions. In addition, while personal DSSs are characterized by their model-base and database components and GDSSs by their coordination tools for group tasks, ODSSs have the features of the enterprise-wide communication network and integration of model base, database, communication and coordination protocols.

A variety of system architectures for ODSSs have been proposed. Some of them keep the basic architectures and components of personal DSSs or GDSSs, and some others incorporate new support functions for new requirements in organizational decision support. The ODSS architecture proposed in (Miller and Nilakanta 1993) keeps the basic architecture of personal DSSs and extends it by connecting the model subsystem, knowledge subsystem, and database subsystem through the communication interfaces with access control. Watson (1990) extends the GDSS architecture by addressing the combination of computer and communication technologies to coordinate and disseminate decision-making across functional areas and hierarchical layers. In architectures of (Swanson and Zmud 1992) and (Holsapple and Whinston 1996), supports to the features of distributed decision-making have been addressed. The architectures provide the access control on the organizational resources for decision-maker groups. Organizational resources are categorized into internal part and external part as well as private part and public part. The architecture proposed in (Philippakis and Green 1988) is an integrated one, which attempts to provide supports at both the strategic level and the operational level. It includes CPS (Corporate Planning System) to support strategic planning process, EIS (Executive Information System) to support top management, FDSS (Functional DSS) to support functional-level decision-making, and LDSS (Local DSS) to support local decision-making activities.

Efforts to apply ODSSs in organizations have been reported in several papers. The application domains include Telecommunication (Pagani and Bellucci 1988; Dondi et al. 1988; Kim et al 1997), military (Carter et al. 1992), hospital (Bright et al. 1996), and retail organization (Perira 1995). However, the development practice is a rather weak area of the ODSS research. Major limitations include: (1) relatively small number of application cases compared with the pervasion organizational decision-making activities; (2) most of the reported applications being only prototypes or conceptual systems instead of real ones; (3) little work done regarding the better using of Internet in ODSSs.

In summary, ODSS research is still at its infant stage. Most of the existing research focuses on the conceptualization and system architecture. A challenge confronting the ODSS research is to develop prototypes or real application systems to see "what bear traps exists out there" (Nunamaker 1992). In particular, utilization of Internet in ODSSs should be further explored to create possible synergy. This paper is an effort along with this line.

A Conceptual Model of Organizational Decision-Making Process

An organization decision task is usually beyond the capability of any individual or group decision-makers. Therefore, it has to be decomposed into subtasks crossing various organizational hierarchies. The subtasks may have to be further decomposed into much smaller tasks. This process will proceed until each independent task can be accomplished by an individual or a group of decision-makers. Along with the decomposition of each task, a decision-making group needs to be created. Such group usually consists of group controller(s) for group coordination as well as decision-makers for the decomposed tasks. The controller(s)

decompose the task, identify group members for these tasks, assign the tasks to them, and coordinate the overall decision-making process of the group. Upon receiving the assigned subtask from the controller(s), each member will first decide to accept or reject the assigned task. If he accepts but it is still too difficult to for him to accomplish the assigned subtask by himself, he has to repeat the decomposition process and create another decision group under him. Having finished the task decomposition and decision group creation, each decision-maker makes his own decision and then reports the results to his group controller(s). This process repeats until the decision-maker who triggers the organizational decision-making has made his decision.

Based on this analysis, we model the organizational decision-making process into two phases: (1) task decomposition and group creation; and (2) decision-making and result synthesis. Figure 1 illustrates a typical organization decision-making process based on our model.

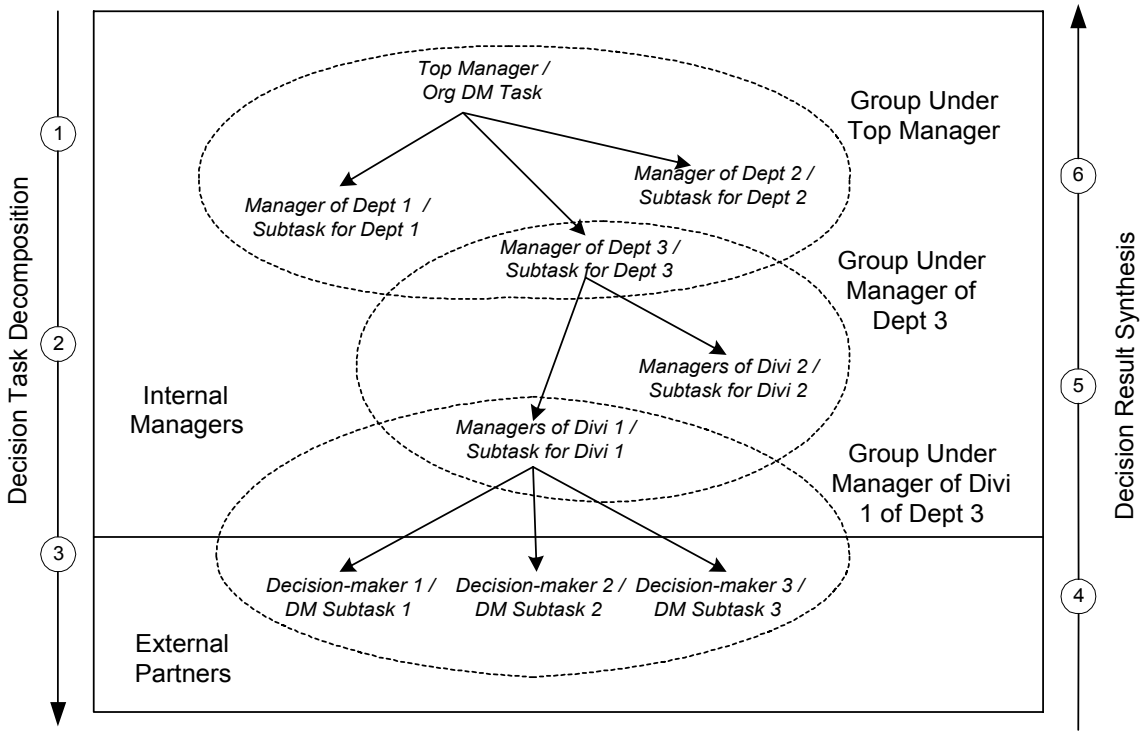

Figure 1. Organizational Decision-Making Process Model

In the task decomposition and group creation phase, (1) the Top Manager of the organization first decomposes the given organizational-wide task, Org DM Task, into three subtasks: Subtask for Dept 1, Subtask for Dept 2, and Subtask for Dept 3. He also creates a group which includes Manager of Dept 1, Manager of Dept 2, and Manager of Dept 3. The three subtasks as well as the corresponding access rights to organizational resource are then assigned to the three departmental managers respectively; (2) Then the three departmental managers further decompose their tasks and assign them to divisional managers. In the figure, the Manager of Dept 3 decomposes his task into two subtasks: Subtask for Divi 1 and Subtask for Divi 2. Similar to what Top Manager has done, he then creates another group and assigns subtasks to its members: Manager of Divi 1 and Manager of Divi 2; (3) Now if the divisional managers still cannot handle the decision-making by themselves, they have to repeat the task decomposition and group creation as what top manager and departmental managers have done. In the figure, the Manager of Divi 1 of department 3 decomposes his task into three further subtasks: DM Subtask 1, DM Subtask 2, and DM Subtask 3. He invites Decision-Maker 1, Decision-Maker 2, and Decision-Maker 3 to take these tasks. Manager of Divi 1 and the three decision-makers form a new decision-making group. It should be noticed that Decision-Maker 1, Decision-Maker 2, and Decision-Maker 3 are from the outside of the organization. In the decision-making and result synthesis phase, (4) As soon as the Decision-Maker 1, Decision-Maker 2, and Decision-Maker 3 finish their subtasks, Manager of Divi 1 of department 3 will summarize the results. He then submits the result of his task to Manager of Dept 3, the controller of the Group by Manager of Dept 3; (5) This process will continue until Manager of Dept 3 completes his task and returns his result to the Top Manager; (6) When the Top Manager gets departmental result-submissions from all members of his group, he will make the final decision by aggregating those results.

According to research findings in organization theory and organizational behavior, organizational decision-making has the two characteristics (Huber 1981; Shapira 1997). First, organizations have relative stable hierarchical structure and the task decomposition is along the organizational hierarchies. Second, there are usually templates about how to decompose organizational decision tasks. Therefore, major functions for organizational decision support system should include: (1) the support for task decomposition and group creation; (2) the support for group coordination; and (3) decision-models, methods, and tools to facilitate result synthesis.

A System Architecture for Organizational Decision Support

The proposed system architecture for ODSSs is in browser-server paradigm as shown in figure 2. The Web browsers and the Web servers are the presentation tier and the application tier respectively. And the servers for database, model-base, and knowledge base constitute the data tier.

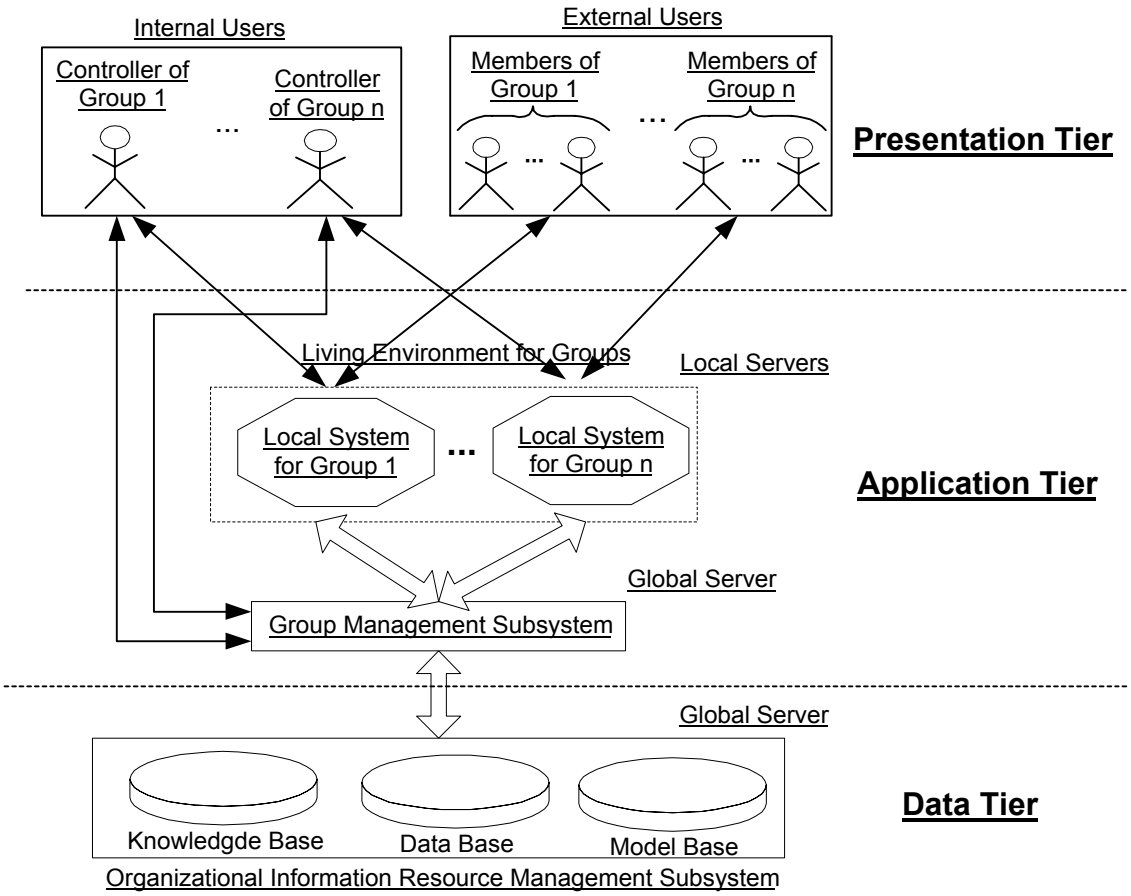

Figure 2. A System Architecture for Organizational Decision Support

The system at the server side consists of the following three components: (1) *Organizational Information Resources Management Subsystem*. It manages the overall information resources of the organizations, including data base, knowledge base, and model base. (2) *Group Management Subsystem*. It is the kernel of the ODSS and will be discussed more carefully in the following subsection. The major function is to facilitate the management of decision-making groups in their life cycle. (3) *Living Environment of Groups*. Groups can exist with the support of web-based systems, email-based systems, electronic meeting systems, workflow systems, text-based or video-based conferencing systems. The living environment provides technique infrastructure for running these systems.

As servers, the Organizational Information Resource Management Subsystem and the Group Management Subsystem are global in the sense that they are shared by all the groups of the organization and cannot be changed by any group without organizational permission. On the other hand, each group maintains a local server which can be configured by the group according at its discretion and limits such service to group members only.

At the client side, users are classified as internal or external. Internal users are usually employees of the organization. After being assigned a task, they normally have the right to create a decision group by using the Group Management Subsystem. In the group, they play the role of the group controllers and coordinate the decision process until the final decision has been reached. They usually have more rights to access the organizational information resources, and the right to control its members' accessibility to such resources. External users are usually the domain experts invited from other organizations being to join in the decision-making process. They normally have fewer rights to access the information resources under the control their group controllers.

The group management subsystem is the most important component of the architecture. It can be understood as a gateway between the groups as well as between the groups and the organizational information resources. It is responsible for managing the overall life cycle of decision-making groups. Specifically, it plays four important roles: group creation, group maintenance, group coordination, and group termination.

(1) *Group Creation*. To support group creation, the following four aspects should be supported by the group management subsystem. (a) Task description. Before task description and assigning, background information has to be provided so as to let group members have the common understanding of the task. Besides, it will also facilitate the communication and coordination among group members. For example, the evaluation criteria and grading rules should be provided for a project evaluation task. (b) Member selection. The responsibilities and abilities to access the organizational information resources should also be determined upon selection of group members. (c) Communication patterns. According to the nature of the task, multiple communication channels may be provided. Emails are usually used though other means may supplement. For example, discussion board such as BBS may be very useful for long-term decision-making. (d) Support tools. Appropriate support tools will facilitate the group work to a great extent. Examples include decision models, visualization tools, decision support systems, group support systems, negotiation support systems, text cluster analysis tools and so on.

(2) *Group Maintenance*. Groups are dynamic as the work proceeds forward. Changes may occur to group tasks, membership, communication patterns, and support tools. The group management system shall be able to facilitate the change and the thus caused task re-planning.

(3) *Group Coordination*. As illustrated in figure 2, an organizational-decision is accomplished by a lot of decision groups. All groups interrelate with each other in a way that a group controller of a subtask is a group member of its parent task. Therefore coordination among groups can be reduced to coordination within groups. Being an important task of the group management system, coordinating activities can benefit from some useful tools such as progress monitor.

(4) *Group Termination*. Similar to the support provided to group creation, the group management system shall also give support to the termination of the group.

As a summary, the proposed architecture incorporates Web technology and provides powerful support for the features of organizational decisions such as multiple-stage, multiple-group of geographically-dispersed decision-makers with timing differences, and heterogeneous computing platforms. Web technology has several advantages in terms of supporting organizational decisions:

(1) Web browsers are available for all popular computing platforms and operating systems, providing access to information in a platform independent manner;

(2) Browsers offer a simple user interface and consistent information presentation across these platforms, and are themselves extensible through association of external helper applications;

(3) Browsers are already part of the computing environment in an increasing number of organizations, requiring no additional installation or maintenance of software for users to cooperate using the Web;

(4) Many organizations have also installed their own Web servers as part of an Internet presence and have familiarity with server maintenance.

A Web-Based Organizational Decision Support System for R&d Project Selection

R&D project selection is an organizational decision-making task commonly found in organizations like government funding agencies, universities, research institutes, and technology-intensive companies. It includes activities of proposal submission, preliminary evaluation, assignment of external reviewers, peer review, validation of review results, panel evaluation, and final decision. It is a complicated and challenging task. A lot of efforts have been made in the past four decades to help organizations make better decisions in R&D project selection. Literature review shows that most of existing literature focuses on building mathematical models at theoretical level. A variety of decision support systems (DSSs) have been developed to improve the applicability of mathematical models. However, there are two limitations in these approaches. First, the elaborated decision models and methods have limited impacts on decision-makings for real-life situations. Second, the DSS approaches merely support decision-making process at individual decision-maker level rather than at organizational level, thus fail to support the whole process of R&D project selection.

In this section, we describe our effort to support R&D project selection by using the proposed framework through Web-technology. This effort aims to support the whole decision-making process and make the decision-making possible at any time and any place.

Since 1999, we have worked to develop an Internet-based Science Information System (ISIS, http://isis.nsfc.gov.cn/) for R&D project selection and management for the National Science Foundation of China (NSFC). Founded in 1986, NSFC is the largest government funding agency in China with the primary aim to promote the fundamental and applied research. Supported by the Chinese government, NSFC's annual budget has been dramatically increased from RMB80 million in 1986 to over RMB1,290 million in 2000. Up to 1999, it has provided financial support for more than 51,500 projects. Every year, NFSC receives more than 25,000 proposals. The project selection process is coordinated by the top managers of NSFC and accomplished by the seven scientific departments as well as their divisions underneath. The overall project selection task is decomposed and assigned to departments, and departments further decompose their tasks and assign to divisions. Divisions will invite external reviewers and experts to evaluate each proposal. For this purpose, it maintains an external reviewer database with more than 30,000 records, and employs more than 700 experts from 69 disciplines for panel evaluation.

Our proposed system architecture has been implemented in ISIS. Technically, it is implemented by using Microsoft Internet Information Server (IIS) and Active Server Pages (ASP). Microsoft Windows NT/2000 Server's Internet Information Server (IIS), accessible from popular browsers, provides all the standard services one expects from a Web server: support for HTTP, Secure Sockets Layer (SSL), common gateway interface (CGI), and so on. In addition, being a part of Microsoft component service, IIS also allows the creation of Active Server Pages (ASP).

ISIS has an organizational resource management system to manage organizational resources such as proposal database, human resource database of internal and external decision-makers, rule-base for proposal validation, model base for decision-models and algorithms. Three categories of users have been defined: the super-user, the internal user, and the external user. The super-user of the system is the project administrator who takes care of the group management system. The internal users are managers from NSFC including top managers, departmental managers, and divisional managers. External users are from the outside of NSFC, which usually include organization-users, principal investigators, and external reviewers. Through the group management system of ISIS, each user is authorized to a certain extent to access the organizational information resources. Internal users like top managers, departmental managers, and divisional managers have the right to create their own decision-making groups. One manager may create different decision-making groups for different decision-making tasks. The group decision-making processes are coordinated by managers involved in groups. Decision models and knowledge rules are provided for managers to facilitate the group decision-making processes.

In 2000 and 2001, ISIS has partially been used for R&D projects selections in NSFC. There are totally fourteen divisions from the seven departments that have used it. The application has provided evidence showing that the whole system improves the decision efficiency and shortens the whole decision lifecycle to a great extent.

Conclusions

Organizational decision-making is usually complicated and difficult to come to a decision because it is usually involved multiple groups of decision-makers and followed multiple stages. Internet provides an ideal infrastructure for organizational decision support. This paper reports our experience in this direction. We start with the proposal of a conceptual model for the organizational

decision-making process. Based on the analysis of normal organizational decision-making process, it is modeled into two phases: (1) task decomposition and group creation; and (2) decision-making and result synthesis. Following the conceptual model to support the tasks for organizational decision-making, a system architecture is proposed incorporating Web techniques because of its advantages in terms of supporting organizational decisions. The system architecture follows the three-tier client/sever model and consists of three parts: organizational information resources management subsystem, group management subsystem and living environment of groups. Finally, a real Web-based ODSS, the application of our framework to the R&D project selection in NSFC, is reported. The usage statistics has shown that the system improves the decision efficiency and shortens the whole decision lifecycle to a great extent.

References

Bright, M. M., Rao, V. S., Walz, D. B., Ashmos, D. P. "An ODSS for Hospital-Based Clinical Decision-making: Conceptual Design and Analysis", in: Proceedings of HICSS-29 III (1996) 72-81.

Carter, G. M. Building Organizational Decision Support Systems, Academic Press Inc., 1992.

Dondi, C., Migliarese, P., Moia, G., and Salamone, G. "An Organizational Decision Support System for Italtel Projects and Internal Resource Planning", In: R. M. McCosh and P. Migliarese, Eds., Organizational Decision Support Systems (North-Holland, 1988).

Fedorowicz, J., and Konsynski, B. "Organization Support Systems: Bridging Business and Decision Processes", Journal of Management Information Systems (8:4), 1992, pp. 5–25.

George, J. F., Nunamaker, J. F., and Valacich, Jr. J. S. "ODSS: Information Technology for Organizational Change", Decision Support Systems (8), 1992, pp. 307-315.

George, J. F. "The Conceptualization and Development of Organizational Decision Support Systems", Journal of Management Information Systems (8:3), 1991-92, pp. 109-125.

Holsapple, C. W., and Whinston, A. B. Decision Support Systems: A Knowledge-Based Approach, West Publishing, St. Paul, MN, 1996.

Huber, G. P. "The Nature of Organizational Decision-Making and the Design of Decision Support Systems", MIS Quarterly, June 1981, pp.1-11.

Kim, Y. G., Kim, H. W., Yoon, J. W., and Ryu, H. S. "Building an Organizational Decision Support System for Korea Telecom: A Process Redesign Approach", Decision Support Systems (19:4), 1997, pp. 255-269.

Miller, L. L., and Nilakanta, S. "Organizational Decision Support Systems: the Use of a Data Extraction Scheme to Facilitate Model-Database Communication", Decision Support Systems (9), 1993, pp. 201-215.

Nunamaker J. "Organizational Decision Support Systems", in: E. A. Stohr and B. R. Konsynski, Eds., Information Systems and Decision Processes, IEEE Computer Society Press, 1992.

Pagani, M., and Bellucci, A. "An Organizational Decision Support System for Telettra's Top Management", in: R. M. McCosh and P. Migliarese, Eds., Organizational Decision Support Systems, North-Holland, 1988.

Perira, A. "Modeling an Organizational Decision Support System to Improve Retailers' Decisions", in: Proceedings of HICSS-28 (3), 1995, pp. 933-940.

Philippakis, A. S., and Green, G. I. "An Architecture for Organization-wide Decision-Support Systems", in: Proceedings of the Ninth International Conference on Information Systems, Minneapolis, Minnesota, 1988, pp. 257-263.

Shapira, Z. Organizational Decision Making, Cambridge University Press, 1997.

Swanson, E. B. and Zmud, R. W. "ODSS Concepts and Architecture", in: E. A. Stohr and B. R. Konsynski, Eds., Information Systems and Decision Processes, IEEE Computer Society Press, 1992.

Watson, R. T. "A Design for an Infrastructure to Support Organizational Decision-Making", in: Proceedings of HICSS-23 (3), (1990), pp. 111-119.