A generic approach for the design of organizational decision support systems (ODSS)

RACHID CHALAL[1]
FAHIMA NADER[2]

System Design Methodology Laboratory (LMCS),
National Institute of Computer Science (INI)
BP 68M Oued Smar, 16270, Algiers, Algeria
[1,2] (r_ Chalal, f_Nader)@)ini.dz

Abstract. The paper proposes a generic approach to design and develop an Organizational Decision Support System (ODSS). This approach is based at the follows definition: the ODSS is considered as the experts' memory and their decision-taking. Therefore, the ODSS is constituted by two elements, a strategic DSS and a specific referential of the decision situation. Our generic approach for ODSS design is based on the MUSIC (Management and Use of Co-operative Information Systems) model. An illustration of the approach is presented. The type of ODSS presented (risk estimation and management of innovative projects made during the bidding phase) is generic among process-oriented organizations.

Keywords: ODSS, DSS, Co-operative information system, Referential, Corporate memory, Project risk management.

(Received April 19, 2006 / Accepted January 03, 2007)

1 Introduction

The decision support [19] represents therefore all the means (models, methods, tools, concepts) that are available to the decision-maker in order to make easier the decision making.

Every decision support tool is equipped with its own realization and implementation methods: KOD methods [26] or KADS [5] for expert systems, ROMC [23] for DSS (Decision Support Systems), KDD (Knowledge Data Discovery) [11] for the knowledge extraction.

Methods are numerous, diversified, not linked up, and use concepts or different formalisms according to tools. Data modeling remains the only almost shared point.

The realization methods for personal DSS are well known: ROMC [23], multicriteria analysis [19]. However, they are not well applied. Needs are not easy to identify and are numerous and scattered. The internal sources of information are not sufficient to satisfy these needs. Therefore, prototyping, interactivity and considering by user are the rule. Besides, these methods do not take into account all the requirements of cognitive decision process, according to the IDC model of Simon [22].

Under the combined effect of increased customer requirements and a harder competition, the decision support had to deal with decision situations where the decision process involves several groups of decision-makers in correlation in the organization. There exist numerous manners, for a group, to take decisions. Decisions that a cooperative work deals with can be collective or distributed [4], depending on whether every actor is only in charge of the resolution of a part of the problem or participates, in the same way as the others, in its resolution.

In this work, we are interested in the cooperative decision making. It works by compromise via a system of contracts between the decision-makers. There is therefore a need for a formal organization in order to coordinate the actions of several decision-makers. To improve the cognitive process of the decision-makers, it is necessary to have decision support aids through an adapted information system (IS). The IS can be used as a cooperative language in the organization through a pivot language that will be used to guide the cooperation in a group. It is structured as a cooperative information system [1], as it helps to produce and to share various and heterogeneous knowledge.

The implementation of a cooperative decision making tool requires a method that allows identifying information needs and sources (internal, external), and offers a design approach.

However, methods did not follow during the realization of decision support tools that would be adapted to these decision situations. It is a matter of ODSS (Organizational Decision Support System). The methods are still not much formalized and remain an abounding domain without a global approach.

The objective of this paper is to present a generic approach for ODSS design. The paper is structured in two parts. In the first one, a definition for the ODSS concept is given, followed by the interest of this tool type for a company. A comparison of ODSS with other tools type of decision supports (DSS, GDSS, EIS) is then made. To show the lack of methods and the absence of methodological consensus for ODSS design, two approaches are reviewed: the fist one offers an ODSS architecture specific to a situation of decision: the project selection in R&D; the second one is based on a generic architecture. In the second part, our generic approach for ODSS design is introduced. It is based on the MUSIC (Management and Use of Co-operative Information Systems) [1] model. An illustration of the approach is finally presented.

2. Organizational Decision Support Systems

An ODSS supports and organizes the division of labor for decision-making inside a firm. It focuses on an organizational process which cuts across organizational functions and hierarchical layers [8]. It supports interrelated but autonomous local decisions, but its main help is to coordinate these multiple local decisions with the objective of optimizing organizational decision. It therefore affects the management level of the company, introducing a process view and work organization of a firm or even of a virtual organization including various companies. It has to satisfy both individual and organizational levels.

At the individual level, it has to:

– Satisfy multiple types of decision-makers, providing individual;

–Improve individual decision models: faster and better identification of problems, multiplication of alternatives examined, and choice upgrading,

– Change individual roles in the organization.

At the organizational level, it has to support basic business processes [8], and:

– Improve coordination and effectiveness of interdependent decisions,

– Support company policy by standardizing guidelines and procedures across the organization and streamlining organizational business processes,

– Affect business directly: improving profits, increasing market share and return on investments, etc.

An ODSS shares some characteristics with other management information systems [15],[12], such as DSS, GDSS and EIS, but it has distinctly different objectives and a broader scope. It has a strong organizational component not present in a DSS or a GDSS and a coordination component not present in an EIS. Hence, compared to other management information systems, an ODSS has different functions and components, and requires different design and development approaches.

A comparison of ODSS with DSS, GDSS and EIS can be done to find some similarities and isolate the specificities. The comparison between ODSS and EIS will be specifically stressed as both are supposed to mainly handle techniques and tools of data mining and knowledge discovery.

2.1 ODSS and DSS

ODSS have to support autonomous decisions and enhance performance of individual decision-makers. Their design process has therefore common factors with traditional DSS, and notably the importance given to the cognitive process of the decision-maker. But ODSS are not just an assemblage of DSS. They are not designed to support many decisions of one individual decision-maker or many independent decisions of individual decision-makers. They support interdependent decisions made by many individuals with multiple interests.

Therefore, since users are diverse and numerous, and the coordination among various units is a higher preoccupation, individual users' requirements are not completely satisfied. Individual users' roles are more portrayed conventionally, and user participation from the very beginning and all along the design is not the utmost rule. Individual users may therefore find ODSS more impersonal and less relevant than an individually designed DSS.

2.2 ODSS and GDSS

GDSS (Group Decision Support Systems) [9][20], are designed to support decision making of a group of people (a team) engaged in a decision-related task.

GDSS are supposed to reduce communication barriers, stimulate or hasten exchange of messages, reduce uncertainty or noise in group's decision process, and drive or regulate the group's decision process.

GDSS technologies are mainly blackboard-type tools, electronic boardrooms, audio-visual conference rooms, group networks... From a knowledge modeling point of view, the main point is to organize the group information center as a "group memory", which provides uniform and consistent knowledge to the group. This information centre is the basis for people learning from the group.

ODSS enhance also performance of working groups. But if GDSS focus on single work teams with little differentiation in roles and relationships regulations, ODSS objectives are to facilitate the interaction of multiple groups, differentiating formally their roles and relationships, and organizing regulation mechanisms. GDSS have to consider social factors that influence group behaviors. ODSS have to consider organizational factors that influence enterprise performance and behavior. Organizational-level decision processes involve issues of greater consequence than group level processes. In ODSS, organizational factors are actually a model of the global work organization of the company. Hence, an ODSS cannot be viewed as a simple extension of a GDSS, just as group support systems cannot be viewed as simple extension of individual DSS.

2.3 ODSS and EIS

Executive Information Systems (EIS) are relevant to wide-ranging decisions made by top executives. They support diverse mix of decisions executives make. As such, they are not restricted to any particular function inside the company. Even if they are built and maintained by professional developers, mainly because of the lack of time for executives, the corresponding computerized systems may have relatively simple modeling capabilities. Data mining and EIS-software are mainly directed at this type of management information systems, as EIS need both:

– Easy access to a large number of internal and external information sources relevant to executive critical success factors,

– And customized presentations which help interpretation by the decision-maker.

Common Traits between EIS and ODSS are:

– Direct use by top-level executives (ODSS are also directed at other users),

– Access to varied sources, both within and outside of the organization,

– Integration of critical success factor or key indicator information,

– And ability to do status reporting, exception reporting, trend analysis, and drill-down investigation.

An already known trend of EIS is to allow lower level managers to get information consistent with top executives and therefore access in some way to EIS, which is a propensity to make it an ODSS. Generally, requirements engineering is made through a Critical Success Factor method. The method first identifies executive goals through executive interviews. Afterwards, information that underlies them is formalized: goals are measured through activities in which satisfactory results will ensure organizational competitiveness; these activities are aggregated in measure/report progress on goals, with both objective measures and subjective assessments.

Information sources are external (e.g., customers) and coordinated from diverse internal sources. Information is both about current results (short-run performance), as well as building for the future. In conclusion, an ODSS provides critical information to managers like an EIS. The objectives and scope of ODSS and EIS are however very different. The purpose of an EIS is primarily to meet the "information needs" of managers, while an ODSS has to:

– Support organizational decision processes and interdependent task execution. It provides therefore coordination mechanisms to ensure that organizational decision processes are optimized; for example: decisions that can be considered good at an individual level can be organizationally inappropriate,

– Provide knowledge sharing,

– Support varied users and their decisions.

3 Architecture of ODSS dedicated to specific decision situations

In the literature, some ODSS architectures that are dedicated to specific decision situations can be found [21], [24]. These architectures, based on the Internet technology, are designed around the "group" concept (management of the groups, management of the interactions). We present in the following an ODSS architecture for the R&D project selection [24] (Figure 1).

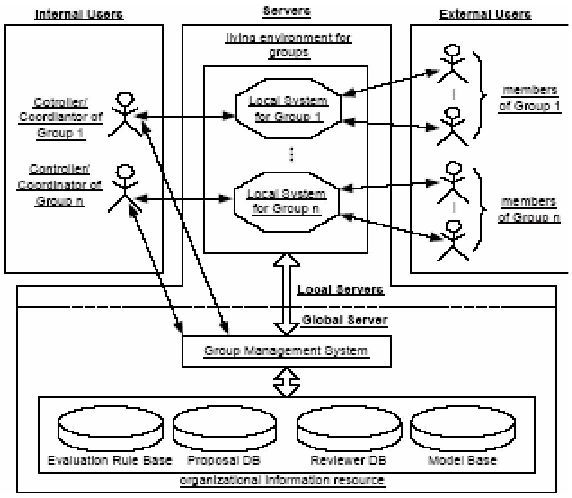

Figure 1. ODSS architecture for R&D project selection [24].

The overall architecture of the ODSS follows a browser/server paradigm. The system, at the server end, consists of three parts:

– Organizational Information Resource Management System: it manages the overall information resources of the organizations, including organization rules guiding project selection, submitted proposals, data concerning people involved in the project selection (staff of the organization and all domain experts), and decision models facilitating project selection decision making,

– Group Management System: it is responsible for the management of the overall life-cycle of decision-making groups. It can be seen as a gateway between the groups as well as between the groups and the organizational information resources. Specifically, it plays the roles of generating groups, maintaining groups, coordinating group activities, and terminating groups,

– Living Environment of Groups: Groups can exist in many ways, including web-based systems, email based systems, electronic meeting systems, workflow systems as well as text/video-based conferencing systems. The living environment provides technique infrastructure for running local systems of individual groups.

The Organizational Information Resource Management System and Group Management System are global and are shared by all the groups. However, they cannot be configured by any single group. Nevertheless, each group is allocated a local server, which can be configured by the group according to its intentions, but only provides services for the members of the group.

From the author's point of view, the ODSS is the result of the modern organizational analysis theories and the design of organization process around the groups. The ODSS is based on the concepts of group, decision-making of the groups and on the interaction of the groups [24]. It is thus, a tool support with the life cycle of each group and with its interactions with other groups of the organization.

4 Generic ODSS architecture

Alone E. Turban [25] represented a generic ODSS architecture by suggesting an evolution of the classical DSS architecture.

According to Turban [25], a DSS is composed of five distinct subsystems. These are a data management subsystem, a model management subsystem, a knowledge management subsystem, a user interface subsystem and the user (who is considered a part of the system).

Two clear structural differences can be noticed between DSS and ODSS (Figure 2):

– First, one of the subsystems making up an ODSS is a case management component. In the same way as

DBMSs and MBMSs are used to manage large databases and model bases, case management systems (CMS) are used in an ODSS in order to manage the large number of similar runs (i.e. runs with inputs which differ only slightly one from the other), which occur in an ODSS,

– Second, an ODSS differs from an ordinary DSS in that it is accessible by several users at the same time, accessing the system from different locations. A DSS does not necessarily have this ability, and there is no support for management of large numbers of similar runs as there is in an ODSS.

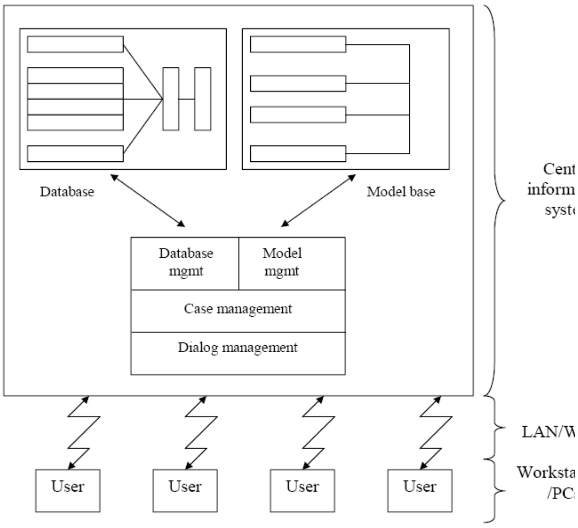

Figure 2. The ODSS Subsystems [25].

Apart from the two clear structural differences between an ODSS and a DSS, the case management component and multi-user access, an intelligent component of some form is also often added to an ODSS.

5 A generic approach for ODSS design

The proposed approach is pulled by requirements and its steps follow up referenced Management Information Systems (MIS) design and development [15],[16],[23] starting from requirements engineering, then defining the knowledge content necessary to decision activities and finally using easy-to-develop tools.

We consider the ODSS as the experts' memory and their decision-taking. Therefore, the ODSS is constituted by two elements (Figure 3), a strategic DSS and a specific referential of the decision situation.

At business level, information aggregation is an absolute necessity. This aggregated knowledge is generally not organized in the companies. This is due to two phenomena:

– They are not produced by the lower levels of hierarchy, even though they come from these levels. At this level, knowledge is detailed, voluminous, and scattered, corresponding to the working procedures and the daily tasks. They are not directly usable at the management level.

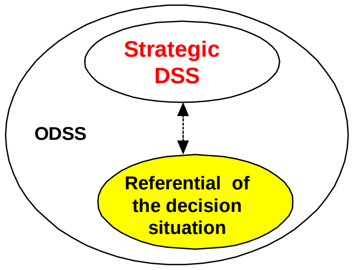

Figure 3. Typical architecture for ODSS design.

– They are not produced by the upper level. On one hand, the managers have difficulties in expressing their expectations and their indicators. On the other hand, when indicators are formulated, it appears that organizational units have difficulties in synthesizing their knowledge as indicators.

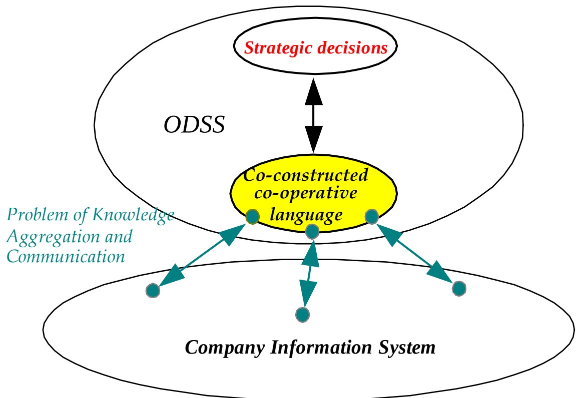

Figure 4. ODSS knowledge sources regarding company's information system

However, this aggregated knowledge has a major interest: the coherence between management and operational level; the implementation of the management directives in daily operations; and the management control.

This aggregation is the result of a co-operative process which builds inside the firm a specific language and knowledge co-constructed by multiple decision-makers, as shown in figure 4.

5.1 Referential of decision situation

The referential insures the cooperation between the group members regarding the situation of strategic decision. It aims at organizing the internal and external sources of information for guiding semi structured and not standardized type decisions. These are:

– Cooperative decisions: they support the organization of cooperative work and come from the collaboration of decentralized decisions,

– Strategic decisions: they support management decisions.

The referential model is based on the MUSIC (Management and Use of Co-operative Information Systems) model [1], which is an Information System structure and a generic model called Co-operative Information Systems Architecture (Figure 5).

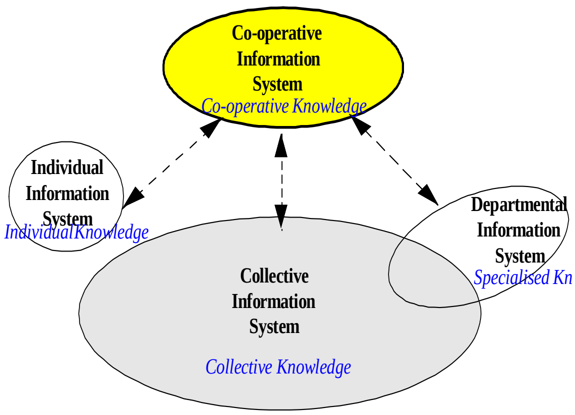

Figure 5. Cooperative model in MUSIC

It includes four sub-systems, linked by an upper co-operative and inter-operative structure:

– The Collective Information System, or whole organization collective semantics. The Organization's efficiency requires coordination that spans an Organization, implying consistency and standardized usage patterns. Collective Information System is the organization skeleton, and is necessary for its survival,

– The Departmental Information System: Information and processes have a specialized semantics which is collective for a limited number of people (for example, a department),

– The Individual Information System: Collective or individual information semantics and individual process semantics. Each decider defines the meaning and aggregation for interpretations, analysis of actions, simulations, etc.

– The global Information System structure is completed by a communication model, defined as the totality of the communications between collective, departmental, and individual Information Systems. It provides exchanges between specialized organizational units to achieve a global finality. It is called Co-operative Information System, defined by cognitive, linguistic and conceptual modeling.

The Co-operative Information System is a conceptual structure which organizes appropriate access to the information needed for strategic decisions from the Information System of the company (Figure 6).

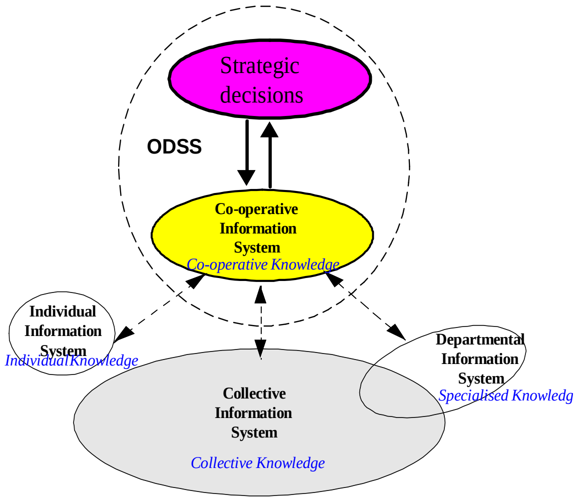

Figure 6. Integration of the ODSS in the information system.

It operates in a distributed context, with Departments considered as independent areas of excellence, outstanding in their own context and for their local decisions: machines, DSS, skills. The access is organized by co-operation with and between departments throughout transverse knowledge and semantics processes. The model of the Co-operative Information System is based on three concepts and related modeling:

– Profoundness information, which corresponds to different degrees of interpretative value and use. Information is considered in terms of levels of interpretation and use: knowledge, linguistic, concept, etc. up to data, which corresponds to the modeling of decision, work organization, and related software design,

– Spatial organization information, which takes into account knowledge heterogeneity and distribution and the related integration. Information is organized into sub-systems (Collective, Departmental, Individual Information sub-Systems), linked by an upper co-operative structure (Co-operative Information System),

– Information diachrony, which corresponds to knowledge diachrony in the organization and the modeling of the temporal evolution of the organization (or change management).

5.2 Typical architecture for strategic DSS

According to Kroenke [15], Sprague [23] and Keen [13], the architecture of a strategic Decision Support System must generally respect the following rules (Figure 7):

–External information and models: representations and models of the decision environment,

–Internal information and models: representations and models of the elements mastered by the decision-maker.

Strategy simulation: to support his final decision, the manager puts into perspective external and internal information, by using the appropriate models.

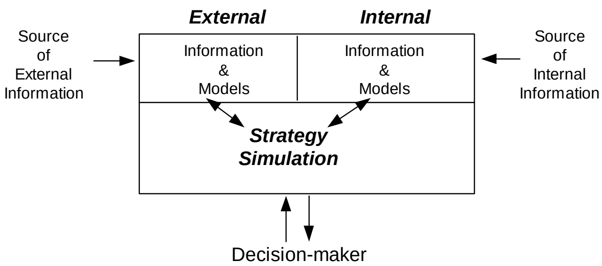

Figure 7. Typical architecture for strategic DSS design.

Helping the decision making process can be synthesized in a dashboard, that is a measure and synthetic reflection tool, adapted to the involved mental processes. The dashboard contains indicators, which it allows to analyze and put in perspective. It aims at helping the decision-maker to organize his way of thinking during his decision making. It generally consists of:

– A group of synthesis indicators. The decision-maker can also base his reasoning on a variety of arrangements between the indicators,

– Analysis and reasoning mechanisms,

– Presentation instruments: report generators, graphs.

6 Illustration of the ODSS design approach

In an era characterized by short product life-cycles, dynamic markets and complex processes, the task of developing new products (or services) is becoming the primary source of sustainable competitive advantage. Competitive advantage is taken into account by focusing on early phases of projects or product life-cycle.

To illustrate our approach, we present an ODSS for project risk management during the early phase of a project (bidding phase). This phase is considered as very important in term of return on investment for users.

6.1 Presentation of the decisional situation

The decision situations are identified according to the company objectives explained above:

Answer to a bidding process only if there is a real possibility to get the contract: go/no go step. The evaluation step "go/no go" takes place as soon as the bidding process is done. It consists of quickly mobilizing the information that is necessary to evaluate the interest or the capability to get the contract. Improve the chances to get the contract. For this purpose, one must be able to elaborate a technical offer that satisfies the client needs at an attractive cost, while minimizing the risks incurred on the product or the industrial processes.

6.2. Referential for project risk management

The decision in the bidding process is a cooperative decision where several actors (logisticians, ecologists, and risks specialists) intervene for very precise contributions. In the bidding process, the cooperative decision support is in fact an ODSS which is inserted into the information system (Figure 8). It must allow:

– Constitute a referential of internal and external risks called RMCM (Risk Management Corporate Memory):

Internal risk is the one that is supposed to be under the control of the company. It is associated to the technical solutions under analysis during the biding process. It is the manufacturer's risk (i.e. industrial or technical risk), about its products, processes and resources: new technology, resources needed for the project or product (partners, components), processes,

External risk is the one that the company does not control. It is related to factors that are external to the company, arising in the company environment: market shifts, government actions, product interactions with the environment (environmental protection, regulation context), market competition, use of the product and product interactions with the customer after product release, external constraints (regulation, legal context, currency fluctuations, customer's country regulation mechanisms and instances).

– Collect and organize information on the knowledge relating to risks;

– Manage information to make easier the access to the knowledge about risks;

– Interact with the corporate memory [18] to constitute the business memory on risks;

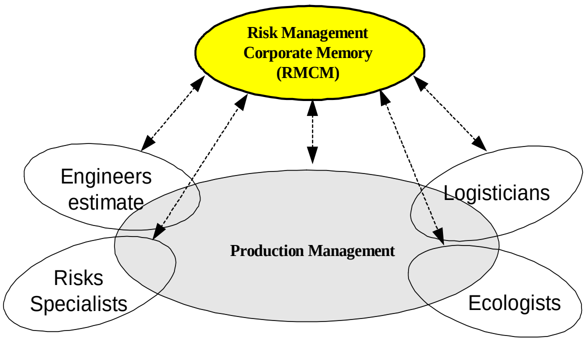

Figure 8. Information system architecture for the bidding process.

The ODSS gain is mainly to improve bid quality and efficiency, helping:

– Early decisions, like bid/no bid or make or buy decisions, as recurrent elements can be used to promptly assemble blue print or sketches,

– Bid construction, allowing to examine more alternatives,

– Analysis and comparison of the solutions built, and notably identify risk drivers and isolate innovative knowledge on which the attention must be focused.

– To identify and decide, early in the life-cycle of the product, actions to seize openings or to avoid and cover major risks (insurance, guarantee,...) susceptible to endanger the future product,

– Preparation of the project itself once the contract is signed. A risk action plan (performance indicators and control scoreboards) can be developed, based on the risks and actions the bid process showed up already.

6.3 Architecture of the ODSS project risk management

The ODSS modeling process (Figure 9) is presented following the three phases of H.A. Simon's definition [22] of problem solving: C or "Choice phase", D or "Design phase" and I or "Intelligence phase".

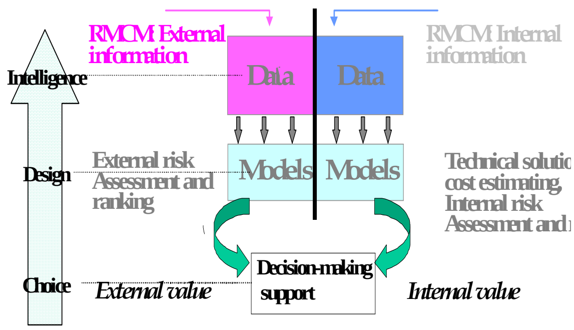

Figure 9. Architecture of the ODSS project risk management.

6.3.1 The Choice phase

ODSS modeling process starts with the Choice phase of the decision activities. This means that the ODSS modeling begins with the analysis of how the decision-maker chooses between different alternatives. The dashboard(s) uses patterns which are global assessment indicators of a project [10]: objectives, time, costs, quality, human resources, performance, processes and risk.

The decision is mainly a trade off between global internal and external risk exposures. External risk exposure -or tolerated risk level- is the independent variable, internal risk -or incurred risk- is the dependent variable.

The indicators are used at several steps of the decision process (bid/no bid, subcontractors and partners' choice, best and final technical solution choice, best and final offer choice, and all along the process of choosing mitigation actions to reduce risk). For example, technical solution criticality evaluation allows mitigating risks to reach an acceptable level of risk exposure, to compare different technical solutions, or to take preventive or curative actions (insurance, provision, double providers...). These factors are quantitative (financial or non-financial) or qualitative.

6.3.2 The Design phase

The Design phase approach uses classical risk assessment methods to estimate risk exposure magnitudes (identification, scaling, ranking, prioritization). Technical solutions building and cost estimating are previous and necessary to risk estimating. This phase takes into account risks as well as opportunities.

Risk exposure is calculated depending on risk categories: cost, schedule, performance. The exposure can be finely expressed as a global exposure/cost. Risk models allow the bid manager to develop alternatives, scenarios, and simulations of mitigation actions impact.

Indicators are evaluated on the basis of AHP (Analytic Hierarchy Process) methods.

6.3.3 The Intelligence phase

The Intelligence phase provides risk identification. This identification is made through the RMCM (Risk Management Corporate Memory) content. Knowledge discovery tools are used, such as Case Based Reasoning.

The RMCM is performed using data mining tools. But the ODSS modeling method is quite different from knowledge discovery and data mining methods [11]. The ODSS modeling process is the inverse (Figure 9): modeling starts from the use and not the data, and useful data do not pre-exist. Knowledge use (decision support) is therefore the first step, and the necessary knowledge sources (RMCM) are defined afterwards. The knowledge that is necessary to the RMCM is not present in the company, but it is co-constructed and emerges from the RMCM presence.

Such business level knowledge has to be built from scratch, using a specific corporate management process and paradigms [1], [14], [17]. Among theses paradigms, a risk ontology is defined as the storage support and the classification of risk knowledge, specifically oriented towards management vision and business reuse.

Knowledge manipulated by the specialized organizational units, as a part of the biding process, is structured around the PBS (Product Breakdown Structure) to support the cooperation between the different actors. It includes:

– The product functions: validate implicit and explicit customer requirements based on the functionalities defined in the biding process,

– PBS and functional analysis: To pass from the functionalities to the components of the future product by engineering approaches. It aims at defining industrial processes and associated resources,

– CBS (Cost Breakdown Structure): allocate cost estimation tasks to company jobs in order to negotiate an objective cost design [2],

– LBS (Logistic Breakdown Structure): insert the support elements as well as the associated processes into the product [7],

– EBS (Environmental Breakdown Structure): analyze the product and the associated industrial processes, from an environmental point of view, to capture the ecological preoccupations [6],

– RBS (Risk Breakdown Structure): manage the risks in relation with the industrial organization of the company in order to negotiate a risk objective design [7].

7 Conclusion

Our approach is based on the following postulate: "ODSS is made of a corporate memory of business level and Strategic DSS". The Memory business is a support for collaborative work. It constitutes the company referential relating to a situation of strategic decision.

The dichotomous structure (internal, external) of strategic DSS allows exploiting existent knowledge of the company and its environment. Besides, the organization of reasoning and decision support aid are based on the model IDC of Simon [22].

This paper presents the approach we proposed. It has been applied for bidding process which is one of 20 key processes of the company and a prototype was developed.

References

[1] Alquier A.M., «MUSIC : Management et Utilisation des Systèmes d'Information Coopératifs», Habilitation à diriger des recherches, Toulouse, 1993.

[2] Alquier A. M., Tignol M. H., « A method for knowledge capitlisation in project management, application to a decision support system for bidding », 14éme congrès sur le management de projets, Slovénie, 10-13 juin 1998.

[3] Alquier A.M, Tignol M.H., « Project management technique to estimate and manage risk of innovative projects », IPMA International Symposium and NORDNET 2001, 31 May - 1 June 2001, Stockholm, Sweden.

[4] Brehmer B., « Distributed decision making: some notes on the literature», in « Distributed decision making: cognitive models for cooperative work », edited by Rasmussen J. Brehmer B. and Leplat J., John Wiley & Sons Ltd, 1991.

[5] Breuker J., Van de Velde W., « CommonKADS Library for expertise modelling, Reusable problem solving components, Frontiers in Artificial Intelligence and Applications », Amsterdam IOS.Press, 1994.

[6] Chalal R., Alquier A.M., « Une approche hybride pour la constitution d'un référentiel risques », CPI'2003, 3rd International Conference: Integrated Design and Production, Maroc, Meknes, 2003.

[7] Chalal R., Nader F., « Constitution d'une mémoire sur les risques dans les projets et son intégration dans le système d'information de l'entreprise industrielle », MOSIM'06, 6e Conférence Francophone de MOdélisation et SIMulation, Rabat, Maroc, du 3 au 5 avril, 2006.

[8] Davenport T.H., «Process innovation; Reengineering work through information technology», Harvard Business School, 1993.

[9] Desanctis G. ,Gallupe R.B., «A foundation for the study of group decision support systems», Management Science, Vol. 33, No. 5, May 1987.

[10] Duncan W.R., « A guide to the Project Management Body of Knowledge (PMBOK) », PMI Standards Committee, 1996.

[11] Fayyad U.M., Piatesky-Shapirob G., Smyth P., Uthurusamy R., « Advances in Knowledge Discovery and Data Mining » AAAI Press/ the MIT Press, 1996.

[12] Holsapple C.W., Whinston A.B., «Decision support systems; a knowledge based approach», West Publishing Company, 1996.

[13] Keen P.G., Sott Morton M.S., « Decision Support Systems», Addison Wesley, 1978.

[14] Kirn S., O'Hare G., «Cooperative knowledge processing», Springer Verlag, 1997.

[15] Kroenke D., Hatch R., «Management Information Systems», McGraw-Hill, 1994.

[16] Mintzberg H. G., «The rise and fall of strategic planning», The Free Press, 1994

[17] Nonaka I., Takeuchi H., «The knowledge creating company - how Japanese companies create the dynamics of innovation», Oxford University Press, 1995.

[18] Pomian J., « Mémoire d'Entreprise, Techniques et Outils de la Gestion du Savoir », Ed. Sapienta, 1996.

[19] Roy B. « Méthodologie multicritères d'aide à la décision », Edition Economica, 1985.

[20] Schmidt K., «Cooperative work: a conceptual framework», in "Distributed decision making: cognitive models for cooperative work", Rasmussen J., Brehmer B., Leplat J. (ed.), John Wiley & Sons Ltd, 1991.

[21] Sen T. K., Laurence J., Hess T.J., «An ODSS for Managing the DOE Hazardous Waste Cleanup Program », Decision Support Systems, vol. 29, Issue 1, Pages 89-109, July 2000.

[22] Simon H.A., « The new science of management decision », New York et Evanston, Harper & Row Publishers, 1960.

[23] Sprague R., Carlson E., «Building effective decision support systems», Prentice Hall, Inc., 1982

[24] Tian Q., Ma J., Liang J., Kwok R., Liu O., «An Organizational Decision Support System for effective R&D Project », Decision Support Systems, vol. 39, Issue 3, Pages 403-413, May 2005.

[25] Turban E., Aronson J.E., «Decision Support Systems and Intelligent Systems», Prentice-Hall International Inc., London, 1998.

[26] Vogel C., « Génie Cognitif », Masson, 1988.