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ARTIFICIAL INTELLIGENCE AND DECISION SUPPORT SYSTEMS

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Abstract: *Decision support systems would consist in the following components): data management component; model management component; user interface management component; decision support system architecture.*

Nowadays, the components of decision support systems are very much like the ones identified by Sprague in 1982: user interface; knowledge based subsystems; data management module; model management module. Most DSSs are applied to structured and semi-structured problems.

A host of new tools and technologies are adding new capabilities to DSS/ESS and will reshape DSS developments in organizations. They include hardware and mathematical software developments, artificial intelligence techniques, the data warehouse/multidimensional databases (MDDB), data mining, online analytical processing (OLAP), enterprise resource planning (ERP) systems, intelligent agents, telecommunication technologies such as World Wide Web technologies, the Internet, and corporate intranets.

Keywords: *Characteristics of DSS, DSS Applications, The future of decision support systems, Single user decision support systems, Knowledge-based decision support systems (Intelligent DSS), The World Wide Web and Group/Organizational/Global DSS.*

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1. INTRODUCTION

According to Sprague and Carlson [Lu03], decision support systems would consist in the following components (Figure 1): data management component; model management component; user interface management component; decision support system architecture.

Nowadays, the components of decision support systems are very much like the ones identified by Sprague in 1982 (Figure 1): user interface; knowledge based subsystems; data management module; model management module.

The user interface is a component that provides the communication between the user and the decision support system. The proper design of this component is really important, as it is the only one the user actually deals with.

The data management method is a subsystem of the computer-based decision support system, and has a number of subcomponents of its own (Figure 2.):

- the integrated decision support system database, which includes data extracted from internal and external sources, data which can be maintained in the database or can be accessed only when is useful;
- the database management system; the database can be relational or multidimensional;

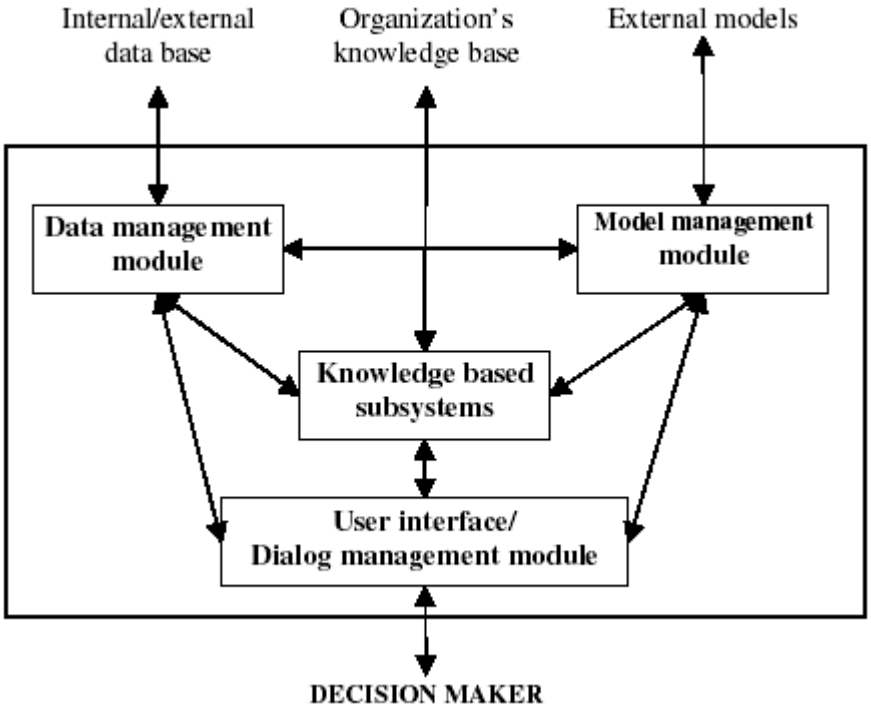

Figure 1

- a data dictionary, implying a catalog containing all the definitions of database data; it is used in the decisional process identification and definition phase;
- query tools, assuming the existence of languages for querying databases.

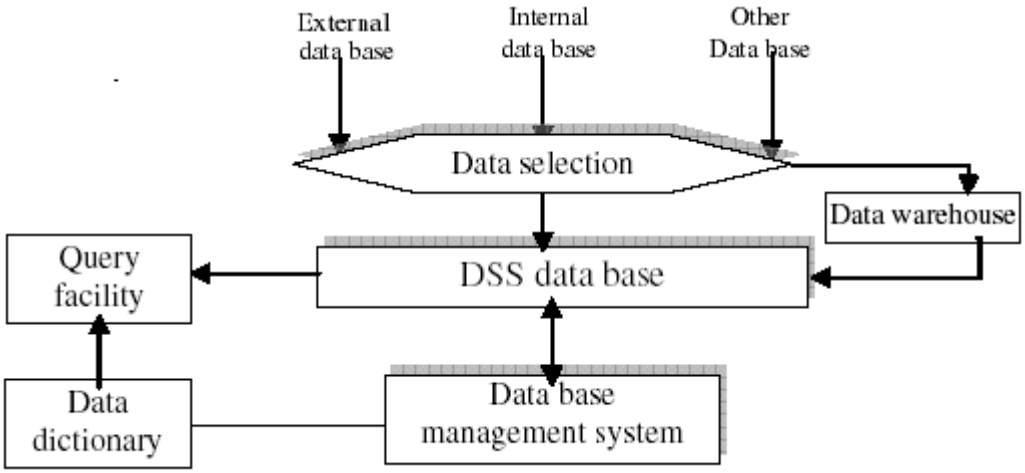

Figure 2

The model management module consists in the following components:

- the model base, that contains the quantitative models that offer the system the capacity of analyzing and finding solutions to problems
- the model base management module, that is meant to create new models by using programming languages;
- the model dictionary, that contains the models' definition and other information related to them;
- the creation, execution and integration module of models, that will interpret the user's instructions according to models and will transfer them towards the model management system.

One naturally raises questions about the future of DSS: will it follow the foot-steps of MIS? A field without definition has the flexibility of expansion and changing direction, but also has the danger of falling apart. Consequently, it is possible to generate heated debate and disagreement. As an example, are the followings DSSs or tools of DSSs:

- non-programmable calculator,
- programmable calculator,
- financial modelling,
- spreadsheet,

- statistics package,
- PERT/CPM/linear programming,
- simulation,
- expert system.

For instance, non-programmable or programmable calculator can be used for calculation during decision making - is it a DSS? Similarly, PERT/CPM can be used for generating alternatives for facilitating decision making by changing parameters and assumptions - is it also a DSS? One may argue that it is possible to use the intention of a design to differentiate DSS from non-DSS. However, it is easy to find counterexamples.

For instance, is a statistics package a DSS? - clearly a statistics package was not intended to be a DSS but is used heavily in decision making under some circumstances• Similarly, some early financial modelling packages (Greenwood, 1969) that were not intended to be DSSs can be adapted to be DSSs by altering the user interface. Nevertheless, some authors have attempted to define the term Decision Support System. Their definitions, however, can be faulted in one way or another• For instance, Keen and Scott Morton (1978) gave an earlier definition of DSS: 'The application of available and suitable computer-based technology to help improve the effectiveness of managerial decision making in semi-structured tasks.' Here, the phrase 'available and suitable computer- based technology' does not have a unique meaning, and varies with time. Furthermore, the term 'semi-structured tasks' is undefined, and may vary from person to person. The reader is invited to consider whether or not computer simulation is a DSS.

2. CHARACTERISTICS OF DSS

- They tend to be aimed at the less well structured, under-specified problems that upper-level managers typically face.
- They attempt to combine the use of model or analytic techniques with traditional data access and retrieval functions.
- They specifically focus on features that make them easy to use by noncomputer people in an interactive mode.
- They emphasize flexibility and adaptability to accommodate changes in the environment and decision-making approach of the user.

3. DSS APPLICATIONS

Most DSSs are applied to structured and semi-structured problems. A list of existing DSS applications, non-exhaustive of course, is given below:

Corporate financial planning

- loan amortization
- depreciation
- lease versus buy
- discounted cash flow and net-present value
- break-even analysis

• Marketing analysis

- forecasting
- sales analysis
- promotion analysis
- consumer sales audits

• Real estate investments

- financing alternative
- cash flows
- impact on taxes
- payoff

• Mineralogical exploration

• Transportation routing

• Portfolio analysis

4. THE FUTURE OF DECISION SUPPORT SYSTEMS

A host of new tools and technologies are adding new capabilities to DSS/ESS and will reshape DSS developments in organizations. They include hardware and mathematical software developments, artificial intelligence techniques, the data warehouse/multidimensional databases (MDDB), data mining, online analytical processing (OLAP), enterprise resource planning (ERP) systems, intelligent agents, telecommunication technologies such as World Wide Web technologies, the Internet, and corporate intranets.

5. SINGLE USER DECISION SUPPORT SYSTEMS

Ever-increasing computing power makes it possible to solve a large-scale mathematical optimization model in a fraction of a second. The size of the problem solvable by commercial software is virtually unlimited, only dependent upon the size of random access memory of computers and the user's patience. Moreover, several solvers are built into the spreadsheet programs such as Microsoft Excel and Borland's Quattro-Pro, along with the capabilities of linking to databases and graphical user interfaces. With the increasing trend of national and global communication networking, single user DSS will increasingly become a part of organization-wide distributed decision-making (DDM) systems. The DDM system consists of several single user DSS that work together and independently to make a sequential decision such as joint production/marketing decisions (Rathwell and Burns 1985). DDM systems work as a mechanism for integrating a number of separate DSSs that coexist in an organization, facilitating group cooperation between several DSSs in a distributed environment, and meeting the specific needs of group planning and group decision making. Notable developments that will significantly affect the future development of DSS are the data warehouse, data mining and intelligent agents. The data warehouse is a subject-oriented, integrated, time variant, and non-volatile (read only) collection of a relational/multidimensional database (MDDB) optimized for decision support, which is separated from operational databases. MDDB organizes data as an n-dimensional cube so that users deal with multidimensional data views such as product, region, sales, time, etc. with a faster query response time. Data mining, also known as Knowledge Data Discovery, refers to discovering hidden patterns/trends/classes/insights/relationships from data, and it attempts to automatically extract knowledge from the in large databases, either in the data warehouse or elsewhere (e.g., spreadsheets, transaction processing system files, etc.) (see DATA WAREHOUSING and DATA MINING).

Intelligent agents (known also as intelligent interfaces, or adaptive interfaces) research is an emerging interdisciplinary research area involving researchers from such fields as expert systems, DSS, cognitive science, psychology, databases, etc. Intelligent agents research has contributed to the emergence of a new generation of active and intelligent DSS and EIS. The active DSS will be equipped with the tools (stimulus agents) that will act as experts, servants, or mentors to decide when and how to provide advice and criticism to the user,

while the user formulates and inquires about its problems under the continuous stimulus of electronic agents. The essence of active decision support activities includes monitoring decision making processes and stimulating creative ideas through carrying out insightful conversations with decision makers.

6. KNOWLEDGE-BASED DECISION SUPPORT SYSTEMS (INTELLIGENT DSS)

An increasing number of systems are incorporating domain knowledge, modelling, and analysis systems to provide users the capability of intelligent assistance. Knowledge base modules are being used to formulate problems and decision models, and analyse and interpret the results. Some systems are adding knowledge-based modules to replace human judgments. Managerial judgments have been used to ascertain (assess) future uncertainty and to select assumptions on which decision models can be based. Some decisions are both knowledge and data intensive. Consequently, a large amount of data usually requires considerable efforts for their interpretation and use.

The knowledge-based DSS include a knowledge management component which stores and manages a new class of emerging AI tools such as machine learning and case-based reasoning and learning. These tools can obtain knowledge from prior data, decisions and examples (cases), and contribute to the creation of DSS to support repetitive, complex real-time decision making. Machine learning refers to computational methods/tools of a computer system to learn from experience (past solutions), data and observations, and consequently alter its behavior, triggered by a modification to the stored knowledge. Artificial neural networks and genetic algorithms are the most notable approaches to machine learning.

The role of knowledge-based DSS should be to allow experts to broaden and expand their expertise, not to narrow it down. Zeleny suggests the important future direction of knowledge-based DSS development in this way

7. THE WORLD WIDE WEB AND GROUP/ORGANIZATIONAL/GLOBAL DSS

The World Wide Web is increasingly being used as the client-server platform of many business organizations due to its network and platform-independence and very low software/installation/maintenance costs. More and more groupware will be inextricably tied to Internet technology. Especially, the World Wide Web is becoming an infrastructure for the next generation of decision support systems and groupware applications. Many

groupware products, such as Lotus Development's Domino and Microsoft's Exchange, are integrating more Internet protocols into them. Microsoft's next version of Office suite is expected to completely remove the boundaries between the World Wide Web and groupware. Many companies are applying groupware technology to increase business-to-business collaborations (e.g. collaborations among the company, its customers, and its suppliers, a.k.a. super workgroup software) over intranets and extranets (see COMPUTER-SUPPORTED COOPERATIVE NETWORK). Another development in the information systems area is the growing importance of enterprise resources planning (ERP) systems. ERP systems are a new generation of information systems packages that integrate information and information-based processes within and across functional areas in an organization. ERP has focused primarily on processing of transaction data resulting in the creation of the extensive, organizational databases of an organization that may consist of individual business units across the globe. The extensive databases created by the ERP system provide the platform for decision support, data warehousing, data mining, and executive support systems. Integrated solutions provided by the ERP system are attributable to the use of the common database.

As we enter the age of the global village where geographical and temporal boundaries are shrinking rapidly, global DSS are emerging as the new frontiers in management information systems area. Over the next decade, DSS will focus on teams, work groups, and distributed, decentralized organizational structures (King 1993). Consequently, many organizations will increasingly design and implement group/organizational/global DSS. Global management support systems (MSS) will emerge as a key element in management decision making and as an essential weapon against global competitors. Supporting global business activities is becoming a most important and extremely complex task.

To effectively cope with multinational managerial problems such as multiple currency management, foreign exchange risk management, global tax management and global consolidated reporting, global DSS are not enough. It is essential to develop an integrated global MSS which integrates EIS, artificial neural networks, ES with knowledge base captured from numerous experts in the same subject area as well as from a variety of specialists in international financial management, international accounting, international tax areas, and so forth.

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