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## An Evaluation Framework of Web-based Decision Support Systems

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### ABSTRACT

Due to the rapid advancement of web technologies in recent years, the concepts and applications of decision support systems have been significantly extended. In this paper we present an integrated framework for developing web-based intelligent decision support systems to facilitate all phases of consumer decision-making process e-services applications. The technology of DSS is evolving rapidly and academic researchers need to catch-up with practitioners who are implementing innovative DSS. This paper reviews and summarizes recent technology developments, current usage of Web-based DSS, and trends in the deployment of such systems. Many firms use the Web as a medium to convey information about DSS products or to distribute DSS software. The paper briefly mentions a number of Web sites with innovative DSS that highlight current developments.

### 1. INTRODUCTION

The advances in computer technologies have affected everyone in the use of computerized support in various activities. Traditional decision support systems focus on computerized support for making decision with respect to managerial problems [1]. Current DSS facilitate a wide variety of decision tasks including information gathering and analysis, model building, sensitivity analysis, collaboration, alternative evaluation, and decision implementation. Often, DSS are built and used for ad hoc analyses, but increasingly, decision support is integrated into business processes and information systems. In the past few years, the World Wide Web [2] has facilitated, nurtured, and promoted a broad resurgence in the use of decision technologies to support decision-making tasks. The global Internet and the World Wide Web are now the primary enabling technologies for delivering computerized decision support. Due to the growing interest in the Web, there are many on-going efforts to develop and implement Web-based DSS in various areas, such as health care, private companies, government, and education. This article surveys the progress in implementing Web-based decision support technologies by examining both academic research and industry practice. A Web-based DSS delivers decision support to a manager or business analyst using a "thin-client" Web browser interface which may integrate client-side computation technologies such as Java applets or JavaScript. [3]

### 2. WEB-BASED DECISION SUPPORT

The Web provides a new medium for storing, presenting, gathering, sharing, processing and using information. A list of benefits of the Web technology is given below.

- The Web provides a distributed infrastructure for information processing.
- The Web is used as a channel to discuss one of the most popular support systems, DSS [4].
- The Web can deliver timely, secure information and tools with user friendly interface such as Internet Explorer and Netscape.
- The Web has no time or geographic restrictions. Users can access the system at any time, any place.
- Users can control and retrieve results remotely and instantly. [5]

In general, all types of Decision Support Systems including- Data-Driven, Model-Driven, Knowledge-Driven, Document-Driven and Communication-Driven DSS can be implemented using Web technologies.

**Model-Driven Decision Support Systems** emphasize access to and manipulation of a statistical, financial, optimization or simulation model. Online analytical processing (OLAP) systems that provide complex analysis of data can be classified as hybrid DSS systems providing both modeling and data retrieval and data summarization functionality. The initial Decision Support Systems discussed in the 1970s by Scott-Morton (1971), Gerrity (1971) and Little (1970) are best classified as Model-Driven Decision Support Systems. [6]

**A Communications-Driven DSS** supports more than one person working on a shared task, examples include integrated tools like Microsoft's NetMeeting<sup>TM</sup>. Communication-Driven DSS supports communication, collaboration and coordination. A Group DSS includes decision models like rating or brainstorming and support for communication, collaboration and coordination.

**Data-Driven DSS or Data-oriented DSS** emphasize access to and manipulation of a time-series of internal company data and sometimes external data.

**Document-Driven DSS** manage, retrieve and manipulate unstructured information in a variety of electronic formats. This type of DSS assists in knowledge categorization, deployment, inquiry, discovery and communication.

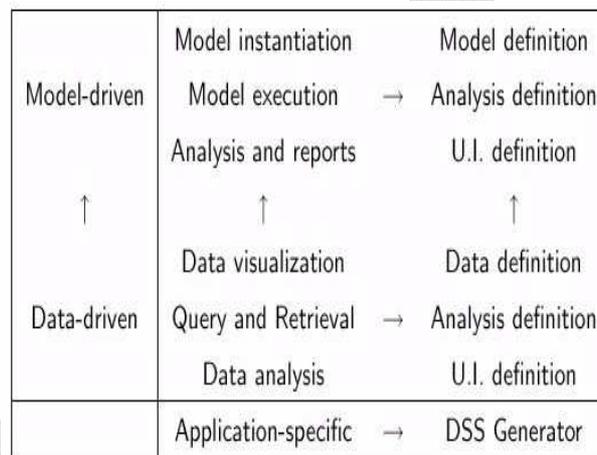
**Knowledge-Driven DSS** have specialized problem solving expertise stored as facts, rules and procedures or in similar structures. The "expertise" consists of knowledge about a particular domain, understanding of problems within that domain, and "skill" at solving some specific problems. [7]

### **2.1. Decision technologies as services**

Bhargava and Krishnan [8] discussed technologies for Web-enablement of DSS, covering technologies that facilitate use of the Web for communication of decision information and computation, technologies that enable the remote and platform-independent access of DSS, and technologies that allow DSS components to be distributed over the Web. As discussed in Bhargava and Krishnan [8], Web technologies can be classified in terms of those technologies that enable (1) server-side computation, (2) client-side computation, and (3) a distributed implementation and deployment of DSS components. Server-side computation facilitates platform-independent and universal access to decision support applications. Relevant technologies include CGI, Java applications, server-side scripting languages, Active Server pages, PHP, and Java server pages. Those technologies enabling client-side computation that allow more capabilities to be embedded in the user interface include client-side scripting languages, Java applets, ActiveX controls, and browser plugins. Finally, those technologies enabling a distributed implementation and deployment of DSS components include CORBA, COM+, Java RMI, and Enterprise Java Beans. More recent technological developments relevant to DSS computation include Web services and messaging protocols such as SOAP, and several XML-related languages and applications for data interchange.

## 2.2. Web technologies and decision support tasks

To understand how Web technologies can influence the development, deployment, and use of Decision Support Systems, we have examined the major tasks at various stages of using and building data- and model-driven DSS. Web technologies are making it possible to perform all of these tasks using a remote Web client. In thinking of such tasks, it is useful to recall the distinction made by Sprague [9] about application-specific DSS that consist of user interface, data, and models for a specific decision problem and DSS generators that provide tools and algorithms for building a variety of specific DSS. Fig. 1 summarizes the relationships among 10 major tasks involved in building and using data- and model-driven DSS. For example, a user of an application-specific, model-driven DSS would have access to relevant decision models and data, and would then focus on tasks such as model execution, development of reports, or analysis. Using a corresponding DSS



**Fig.1 Working with Decision Support Systems: Common tasks**

generator, on the other hand, would require the performance of additional tasks such as model definition and creation of a custom user interface. Building model-driven DSS often involves completing all of the tasks in the model rows as well as the tasks in the data-driven DSS rows. Similarly, using a DSS generator involves the tasks listed in the DSS generator column as well as those tasks for building an application-specific DSS. The 10 distinct DSS-related tasks that can be executed by users from a Web browser include model instantiation, model execution, creation of analyses and reports, data visualization, query and retrieval, data analysis, model definition, data definition, analysis definition, and user interface definition (see, e.g., [10] for more details about these tasks). From a browser, one can create decision support capabilities for other users or use predefined capabilities for a specific analysis.

## 1. A FRAMEWORK OF WEB-BASED DECISION SUPPORT SYSTEMS

A Web-based support system is a support system with the Web and Internet as the interface.

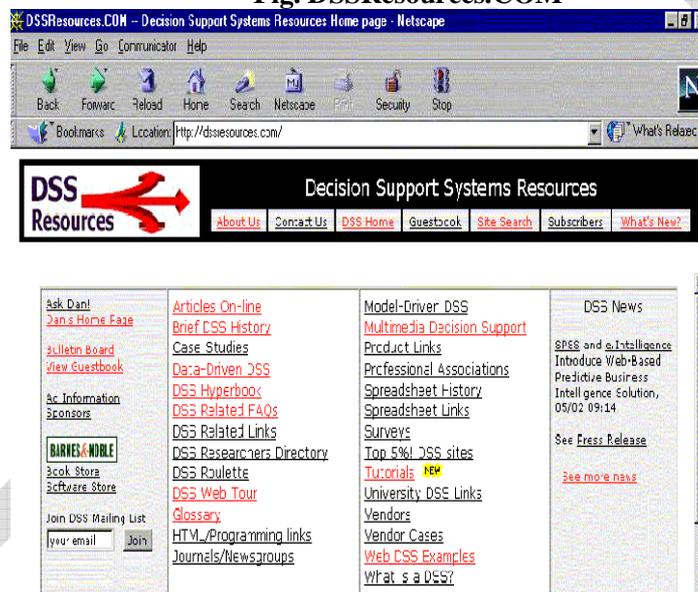
Web-based support systems can be classified into three levels. The first level is support for personal activities. An example of such support is research support for individuals [11]. Personal research activities such as search, retrieval, reading and writing are supported. The second level is the organizational support, such as research support on an institute level [12]. The top level is the network level. The collaborations between organizations or decision making by a group of people like in group decision support systems fall in this level. The group decision support room may be a virtual room on the Web.

A useful framework for thinking about ways in which decision support can exploit the Web is the twin perspectives of “Web as media” and “Web as computer” (Bhargava and Krishnan [8]).

### Examples of Web based DSS

A number of Web sites have information on Decision Support Systems. For example, the Data Warehousing Information Center at URL <http://www.dwinfocenter.org/> has an extensive list of tools and tool vendors. DSSResources.COM at URL <http://dssresources.com/> has articles on DSS, a glossary and links to companies that market DSS products.

Fig. DSSResources.COM



Many DSS vendors have Web-based DSS products and a number of vendors have examples of their products at their Web sites. For example, InterNetivity (<http://www.internetivity.com/>) has eleven data cubes that can be analyzed with their Java Web-based data reporting and analysis product dbProbe. Also, many retail and portal Web sites have Web-Based DSS.

Microsoft Carpoint at URL <http://carpoint.msn.com> demonstrates a Web-Based DSS. Users can search a usedcar database and use the Kelley Blue Book to establish a standard price for a particular make and model. The Compare it! feature permits pair-wise comparison of newcar alternatives across multiple pre-specified attributes. The Payment Calculator is a Java™ applet.

drkoop.com at URL <http://drkoop.com> has a DrugChecker application to help make sure the medications a person takes do not interact with each other or with food to cause an adverse reaction. At drkoop.com users can also find more than 20 "Health Calculators" on topics like stress, nutrition and fitness.

Netscape's Decision Guides are examples of Model-Driven Web-Based DSS. More than 25 Decision Guides are available at <http://home.netscape.com/decisionguides>. Topics for guides include choosing pets, bikes and business schools.

An excellent example of a Model-Driven DSS on the Web that uses a financial model and a large database is the Intrinsic Value Calculator at <http://www.quicken.com>.

The financial valuation model calculates a hypothetical value called the intrinsic value per share based on a company's earnings. The earnings data and other needed values are taken from an extensive company financial database. DSS users are presented with an initial set of parameters and a preliminary calculation of intrinsic value, users can then conduct "what if?" analyses. For example, users can choose a specific historical growth rate or choose a growth rate that seems appropriate. [7]

## 2. RECENT RESEARCH IN WEB-BASED DECISION SUPPORT SYSTEM

This section reviews and summarizes the state of Web-based DSS research in two areas: (a) architectures and technologies and (b) applications and implementations. A number of articles have reviewed more specific topics related to Web-based DSS. For example, Kuljis and Paul [13] reviewed Web-based simulation and Kersten and Noronba [14] reviewed Web based negotiation support.

### 4.1 Architectures and technologies

A number of articles discuss architectural issues, frameworks, usability, and other technology topics that are generally applicable to Web-based DSS. Gregg et al. [15] developed a DSS metadata model for distributing decision support systems on the Web. Bharati and Chaudhury [16] conducted an empirical study to investigate customers' satisfaction with a Web-based decision support system. Iyer et al. [17] studied model management for decision support in a computing environment where enterprise data and models are distributed. Guntzer et al. [18] proposed Structured Service Models that use a variant of structured modeling. This proposed approach can help users find information resources available as an online service within an Intranet. Zhang and Goddard [19] applied Software Architectures to the design of Web-based DSS. Mitra and Valente [20] provided an overview of Web based optimization for model-driven decision support, discussed two paradigms (ASP and e-Services), and articulated technology issues for an e-Services model.

### 4.2 Applications and implementations

Many researchers and vendors have reported Web based DSS case studies and the development of prototype applications. Kohli et al. [21] reported a case study of a Web-based DSS for hospital management called Physician Profiling System (PPS). Ngai and Wat [22] developed and implemented a Web-based DSS that used a model based on fuzzy set theory to perform risk analysis for e-commerce development. Dong et al. [23] developed a Web-based DSS framework for portfolio selection. Sundarraj [24] identified key issues in managing service contracts and developed a prototype that can support a manager's planning process. Ray [25] reported a case study that demonstrates the implementation of Web-based decision support technologies. Delen et al. [26] developed a Web-based DSS, called MovieForecast Guru, to help decision makers in the movie industry. There are many additional case studies related to deploying Web-based decision support systems. For example, Sugumaran and Meyer [27] report the development of a Spatial DSS prototype for the City of Columbia, Missouri.

## 5. CONCLUSIONS

Web-Based DSS have reduced technological barriers and made it easier and less costly to make decision relevant information and Model-Driven DSS available to managers, staff users, customers and suppliers. The Web has increased access to DSS and it should increase the use of well-designed decision support systems. Using a Web infrastructure for building DSS can improve the rapid dissemination of "best

practices" analysis and decisionmakingframeworks and it should promote moreconsistent decision-making on repetitive tasks. Managers and MIS professionals should note that Web-Based DSS could provide companies with acompetitive advantage. These proprietary systems willprimarily impact internal decision processes and make them faster and more predictable. Web-Based DSS canalso improve customer service where a decision isrequired. The Web is wherethe DSS action is today. Mostmajor DSS software vendors have made a majorcommitment to the Web for providing productinformation and for creating new DSS products. VisitingDSS Web sites is a great learning experience for students,teachers and practitioners. Reading Web documents andusing Web-Based DSS provides invaluable informationabout current DSS topics.Overall, Web-Based Decision Support Systems show great promise for contributing to the success of organizations, but more research can help improve thedesign and implementation of these systems.

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