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On Decision Support Systems and It's Application to the Clinical Decisions

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Abstract. Decision Support Systems (DSS) have been built and investigated by Information Systems researchers and technologists for approximately 40 years. This paper chronicled and explored the developments of DSS, theory developments in the 1970s, and the implementation of financial planning systems, spread sheet DSS and Group DSS in the early and mid 80s. Data warehouses, Executive Information Systems, OLAP and Business Intelligence evolved in the late 1980s and early 1990s. the exploration continue with knowledge-driven DSS and the implementation of Web-based DSS from the mid-1990s to now.We finally take the Clinical Decision Support System（CDSS）as example to illustrate the application of DSS.

Keywords: Decision Support Systems (DSS); OLAP**;**CDSS

1. Introduction

A decision support system (DSS) is a computer-based information system that supports business or organizational decision-making activities. DSSs serve the management, operations, and planning levels of an organization and help to make decisions, which may be rapidly changing and not easily specified in advance.

A properly designed DSS is an interactive software-based system intended to help decision makers compile useful information from a combination of raw data, documents, personal knowledge, or business models to identify and solve problems and make decisions.

The history of the implementation of such systems begins in the mid-1960s. Different people perceive the field of DSS from various points (Eom & Lee, 1990b; McCosh & Correa-Perez, 2006; Silver, 1991). Researchers used multiple frameworks to help build and understand these systems. Today one can organize the history of DSS into the five broad DSS categories ,including: communications-driven, data-driven, document driven, knowledge-driven and model-driven decision support systems.

2. History of Decision Support Systems

According to Keen (1978), the concept of decision support has evolved from two main areas of research: The theoretical studies of organizational decision making done at the Carnegie Institute of Technology during the late 1950s and early 1960s, and the technical work on interactive computer systems, mainly carried out at the Massachusetts Institute of Technology in the 1960s. It is considered that the concept of DSS became an area of research of its own in the middle of the 1970s, before gaining in intensity during the 1980s. In the middle and

late 1980s, executive information systems (EIS), group decision support systems (GDSS), and organizational decision support systems (ODSS) evolved from the single user and model-oriented DSS.

According to Sol (1987) ,the definition and scope of DSS has been migrating over the years. In the 1970s DSS was described as "a computer based system to aid decision making". Late 1970s the DSS movement started focusing on "interactive computer-based systems which help decision-makers utilize data bases and models to solve ill-structured problems". In the 1980s DSS should provide systems "using suitable and available technology to improve effectiveness of managerial and professional activities", and end 1980s DSS faced a new challenge towards the design of intelligent workstations

In 1987 Texas Instruments completed development of the Gate Assignment Display System (GADS) for United Airlines. This decision support system is credited with significantly reducing travel delays by aiding the management of ground operations at various airports, beginning with O'Hare International Airport in Chicago and Stapleton Airport in Denver Colorado.

Beginning in about 1990, data warehousing and on-line analytical processing (OLAP) began broadening the realm of DSS. As the turn of the millennium approached, new Web-based analytical applications were introduced.

The advent of better and better reporting technologies has seen DSS start to emerge as a critical component of management design. Examples of this can be seen in the intense amount of discussion of DSS in the education environment.

DSS also have a weak connection to the user interface paradigm of hypertext. Both the University of Vermont PROMIS system (for medical decision making) and the Carnegie Mellon ZOG/KMS system (for military and business decision making) were decision support systems which also were major breakthroughs in user interface research. Furthermore, although hypertext researchers have generally been concerned with information overload, certain researchers, notably Douglas Engelbart, have been focused on decision makers in particular

As with the definition, there is no universally-accepted taxonomy of DSS either. Different authors propose different classifications. Using the relationship with the user as the criterion, Haettenschwiler differentiates passive, active, and cooperative DSS. A passive DSS is a system that aids the process of decision making, but that cannot bring out explicit decision suggestions or solutions. An active DSS can bring out such decision suggestions or solutions. A cooperative DSS allows the decision maker (or its advisor) to modify, complete, or refine the decision suggestions provided by the system, before sending them back to the system for validation. The system again improves, completes, and refines the suggestions of the decision maker and sends them back to him for validation. The whole process then starts again, until a consolidated solution is generated.

Another taxonomy for DSS has been created by Daniel Power. Using the mode of assistance as the criterion, Power differentiates communication-driven DSS, data-driven DSS, document-driven DSS, knowledge-driven DSS, and model-driven DSS.(1)A communication-driven DSS supports more than one person working on a shared task; examples include integrated tools like Microsoft's NetMeeting or Groove;(2)A data-driven DSS or data-oriented DSS emphasizes access to and manipulation of a time series of internal company data and, sometimes, external data;(3)A document-driven DSS manages, retrieves, and manipulates unstructured information in a variety of electronic formats;(4)A knowledge-driven DSS provides specialized problem-solving expertise stored as facts, rules, procedures, or in similar structure;(5)A model-driven DSS emphasizes access to and manipulation of a statistical, financial, optimization, or simulation model. Model-driven DSS use data and parameters provided by users to assist decision makers in analyzing a situation; they are not necessarily data-intensive. Dicodess is an example of an open source model-driven DSS generator.

Beginning in 1995, the World-wide Web and global Internet provided a technology platform for further extending the capabilities and deployment of computerized decision support. The release of the HTML 2.0 specifications with form tags and tables was a turning point in the development of web-based DSS.In addition to Web-based, model-driven DSS, researchers were reporting Web access to data warehouses. DSS Research Resources was started as a web-based collection of bookmarks. By 1995, the World-Wide Web (Berners-Lee, 1996) was recognized by a number of software developers and academics as a serious platform for implementing all types of Decision Support Systems (cf., Bhargava & Power, 2001).The goal was to provide a

useful starting point for accessing Web-based material related to the design, development, evaluation, and implementation of Decision Support Systems. In 1996-97, corporate intranets were developed to support information exchange and knowledge management. The primary decision support tools included ad hoc query and reporting tools, optimization and simulation models, online analytical processing (OLAP), data mining and data visualization (cf., Powell, 2001). Enterprise-wide DSS using database technologies were especially popular in Fortune 2000 companies (Power, 1997).

In 1999, vendors introduced new Web-based analytical applications. Many DBMS vendors shifted their focus to Web-based analytical applications and business intelligence solutions. In 2000, application service providers (ASPs) began hosting the application software and technical infrastructure for decision support capabilities. 2000 was also the year of the portal. More sophisticated "enterprise knowledge portals" were introduced by vendors that combined information portals, knowledge management, business intelligence, and communications-driven DSS in an integrated Web environment (cf., Bhargava and Power, 2001).

3. Development of Decision Support Systems

DSS pioneers came from a wide variety of backgrounds and faced many challenges that they successfully overcame to demonstrate the value of using computers, information technologies and specific decision support software to enhance and in some situations improve decision making. The future of decision support systems will certainly be different than the opportunistic and incremental innovations seen in the recent past.DSS practice, research and technology continue to evolve. Arnott and Pervan (2005) traced the evolution of DSS using seven sub-groupings of research and practice: personal DSS, group support systems, negotiation support systems, intelligent DSS, knowledge management-based DSS, executive information systems/business intelligence, and data warehousing. These sub-grouping overlap, but reflect the diverse evolution of prior research.

Historians use two approached to apply the past to the future: reasoning by analogy and projection of trends. In many ways computerized decision support systems are like airplanes, coming in various shapes, sizes and forms, technologically sophisticated and a very necessary tool in many organizations.DSS research and development will continue to exploit any new technology developments and will benefit from progress in very large data bases, artificial intelligence, human-computer interaction, simulation and optimization, software engineering, telecommunications and from more basic research on behavioral topics like organizational decision making, planning, behavioral decision theory and organizational behavior.

Trends suggest that data-driven DSS will use faster, real-time access to larger, better integrated databases. Model-driven DSS will be more complex, yet understandable, and systems built using simulations and their accompanying visual displays will be increasingly realistic. Communications-driven DSS will provide more real-time video communications support. Document-driven DSS will access larger repositories of unstructured data and the systems will present appropriate documents in more useable formats. Finally, knowledge-driven DSS will likely be more sophisticated and more comprehensive. The advice from knowledge-driven DSS will be better and the applications will cover broader domains.

DSS as an academic discipline is likely to follow a path similar to computer architecture and software engineering and become more rigorous and more clearly delineated. DSS consulting, teaching and research can be mutually supportive and each task can help establish a niche for those interested in building and studying DSS whether in Colleges of Information, Business or Engineering.

4. DSS Application to the Clinical Decisions

There are several ways to classify DSS applications. Not every DSS fits neatly into one of the categories, but may be a mix of two or more architectures. Holsapple and Whinston classify DSS into the following six frameworks: Text-oriented DSS, Database-oriented DSS, Spreadsheet-oriented DSS, Solver-oriented DSS, Rule-oriented DSS, and Compound DSS.

A compound DSS is the most popular classification for a DSS. It is a hybrid system that includes two or more of the five basic structures described by Holsapple and Whinston. The support given by DSS can be

separated into three distinct, interrelated categories: Personal Support, Group Support, and Organizational Support.

As mentioned above, there are theoretical possibilities of building such systems in any knowledge domain.

One example is the clinical decision support system(**CDSS**) for medical diagnosis. Clinical decision support system is an interactive decision support system Computer Software, which is designed to assist physicians and other health professionals with decision making tasks, as determining diagnosis of patient data. A working definition has been proposed by Dr. Robert Hayward of the Centre for Health Evidence; CDSS link health observations with health knowledge to influence health choices by clinicians for improved health care". This definition has the advantage of simplifying Clinical Decision Support to a functional concept. A CDSS has been coined as an active knowledge systems, which use two or more items of patient data to generate case-specific advice. This implies that a CDSS is simply a DSS that is focused on using knowledge management in such a way to achieve clinical advice for patient care based on some number of items of patient data

The main purpose of modern CDSS is to assist clinicians at the point of care.[2] This means that a clinician would interact with a CDSS to help determine diagnosis, analysis, etc. of patient data. Previous theories of CDSS were to use the CDSS to literally make decisions for the clinician. The clinician would input the information and wait for the CDSS to output the "right" choice and the clinician would simply act on that output. The new methodology of using CDSS to assist forces the clinician to interact with the CDSS utilizing both the clinician's knowledge and the CDSS to make a better analysis of the patients data than either human or CDSS could make on their own. Typically the CDSS would make suggestions of outputs or a set of outputs for the clinician to look through and the clinician officially picks useful information and removes erroneous CDSS suggestions.

There are two main types of CDSS:Knowledge-Based and NonKnowledge-Based

An example of how a CDSS might be used by a clinician comes from the subset of CDSS-DDSS (Diagnosis Decision Support Systems). A DDSS would take the patients data and propose a set of appropriate diagnoses. The doctor then takes the output of the DDSS and figures out which diagnoses are relevant and which are not.

Another important classification of a CDSS is based on the timing of its use. The doctor uses these systems at point of care to help them as they are dealing with a patient, with the timing of use as either pre-diagnoses, during diagnoses, or post diagnoses. Pre-diagnoses CDSS systems are used to help the physician prepare the diagnoses. CDSS used during diagnoses help review and filter the physician's preliminary diagnostic choices to improve their final results. And post-diagnoses CDSS systems are used to mine data to derive connections between patients and their past medical history and clinical research to predict future events.

Most CDSS consist of three parts, the knowledge base, inference engine, and mechanism to communicate. The knowledge base contains the rules and associations of compiled data which most often take the form of IF-THEN rules. If this was a system for determining drug interactions, then a rule might be that IF drug X is taken AND drug Y is taken THEN alert user. Using another interface, an advanced user could edit the knowledge base to keep it up to date with new drugs. The inference engine combines the rules from the knowledge base with the patient's data. The communication mechanism will allow the system to show the results to the user as well as have input into the system.

Other CDSS that do not use a knowledge base use a form of artificial intelligence called machine learning, which allow computers to learn from past experiences and/or find patterns in clinical data. Two types of non-knowledge-based systems are artificial neural networks and genetic algorithms.

Artificial neural networks use nodes and weighted connections between them to analyze the patterns found in the patient data to derive the associations between the symptoms and a diagnosis. This eliminates the need for writing rules and for expert input. Genetic Algorithms are based on simplified evolutionary processes using directed selection to achieve optimal CDSS results. The selection algorithms evaluate components of random sets of solutions to a problem. The solutions that come out on top are then recombined and mutated and run through the process again. This happens over and over till the proper solution is discovered.

5. Conclusions

The history of DSS covers a relatively brief span of years, and the concepts and technologies are still evolving. Today it is still possible to reconstruct the history of Decision Support Systems (DSS) from retrospective accounts from key participants as well as from published and unpublished materials. Many of the early innovators and early developers are retiring but their insights and actions can be captured to guide future innovation in this field. It is hoped this paper leads to retrospective accounts that can help us understand the "real" history of DSS. The Internet and Web have speeded-up developments in decision support and have provided a new means of capturing and documenting the development of knowledge in this research area. The DSS pioneers created particular and distinct streams of technology development and research that serve as the foundation for much of today's work in DSS.

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7. References

[1] Alter, S.L., "A Study of Computer Aided Decision Making in Organizations," Ph.D. dissertation, M.I.T., 1975.

[2] Arnott, D. and G. Pervan, "A critical analysis of decision support systems research", Journal of Information Technology, 20, 2, 2005, 67-87.

[3] Dhar, V. and R. Stein. Intelligent Decision Support Methods: The Science of Knowledge. Upper Saddle River, NJ: Prentice-Hall, 1997.

[4] Eom, S.B. and S. M. Lee. "DSS Applications Development Research: Leading Institutions and Most Frequent Contributors (1971-April 1988)," Decision Support Systems (6)3, 1990, 269-275.

[5] Keen, P. G. W. and M. S. Scott Morton, Decision Support Systems: An Organizational Perspective. Reading, MA: Addison-Wesley, 1978.

[6] Power, D. J., Decision Support Systems: From the Past to the Future, Proceedings of the 2004 Americas Conference on Information Systems, New York, NY, August 6-8, 2004, 2025-2031.

[7] Silver, M.S., Systems that Support Decision Makers: Description and Analysis, New York: John Wiley & Sons, 1991.