1 Historical overview of Decision Support Systems (DSS)

1.1 Introduction

During the late 1970s the term "Decision Support Systems" was first coined by P.G.W. Keen, a British Academic then working in the United States of America. In 1978, Keen and Scott Morton published a book entitled *Decision Support Systems: An Organizational Perspective* (Keen and Scott Morton, 1978) wherein they defined the subject title as computer systems having an impact on decisions where computer and analytical aids can be of value but where the manager's judgment is essential. Information Systems (IS) researchers and technologists have developed and investigated Decision Support Systems (DSS) for more than thirty-five years (Power, 2003b).

The structure of this chapter is as follows: The background to DSS will be given. Some DSS definitions, a discussion of DSS evolution, development of the DSS field and frameworks are then presented. Some future trends for DSS are then suggested.

1.2 Background

Van Schaik (1988) refers to the early 1970s as the era of the DSS concept because during this period the concept of DSS was introduced. DSS was a new philosophy of how computers could be used to support managerial decision-making. This philosophy embodied unique and exciting ideas for the design and implementation of such systems. There has been confusion and controversy in respect of the interpretation of the decision support system notion and the origin of this notion originated in the following terms:

- **Decision** emphasises the primary focus on decision-making in a problem situation rather than the subordinate activities of simple information retrieval, processing or reporting;
- **Support** clarifies the computer's role in aiding rather than replacing the decision maker; and
- **System** highlights the integrated nature of the overall approach, suggesting the wider context of machine, user and decision environment.

DSS deal with semi-structured and some unstructured problems.

1.3 Decision Support Systems

With the ever-increasing advances in computer technology, new ways and means of computer-assisted decision-making was born. As a result hereof, over the passage of time, different DSS definitions arose:

- Little (1970) defines DSS as a "model-based set of procedures for processing data and judgments to assist a manager in his decision making" (*sic*);
- the classical definition of DSS, by Keen and Scott Morton (1978), states that "Decision Support Systems couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions. It is a computer-based support system for management decision makers who deal with semi-structured problems";
- Mann and Watson (1984) state that "a decision support system is an interactive system that provides the user with easy access to decision models and data in order to support semi-structured and unstructured decision-making tasks";
- Bidgoli (1989) defines DSS as "a computer-based information system consisting of hardware/software and the human element designed to assist any decision-maker at any level. However, the emphasis is on semi-structured and unstructured tasks";
- Sprague and Watson (1996) define a DSS as computer-based systems that help decision makers confront ill-structured problems through direct interaction with data and analysis models;
- Sauter (1997) notes that DSS are computer-based systems that bring together information from a variety of sources, assist in the organisation and analysis of information and facilitate the evaluation of assumptions underlying the use of specific models; and
- Turban *et al.* (2005) broadly define a DSS as "a computer-based information system that combines models and data in an attempt to solve semi-structured and some unstructured problems with extensive user involvement".

From these definitions it seems that the basis for defining DSS has been developed from the perceptions of what a DSS does (*e.g.* support decision-making in semi-structured or unstructured problems) and from ideas about how a DSS's objectives can be accomplished (*e.g.* the components required and the necessary development processes).

Bidgoli (1989) contends that as the DSS field is in a state of flux, an exact definition of DSS is elusive. Turban (1995) indicates that previous researchers have collectively ignored the central issue in DSS; that is, "support and improvement of decision-making". Bidgoli (1989) suggests that there are several requirements for a DSS which must embrace a definition of a DSS. These are that a DSS

- requires hardware;
- requires software;
- requires human elements (designers and end-users);
- is designed to support decision-making;
- should help decision makers at all levels; and
- emphasises semi-structured and unstructured tasks.

Turban (1995) states that there is no consensus on what a DSS is and there is therefore no agreement on the characteristics and capabilities of DSS. As the definition by Turban *et al.* (2005) underscores Bidgoli's (1989) DSS requirements, for the purposes of this chapter, the DSS definition by Turban *et al.* (2005) will be used.

1.4 Evolution of DSS

During the 1970s and 1980s, the concept of DSS grew and evolved into a field of research, development and practice (Sprague and Watson, 1996). Clearly DSS was both an evolution and a departure from previous types of computer support for decision-making.

Currently DSS can be viewed as a third generation of computer-based applications. Sprague and Watson (1996) note that initially there were different conceptualisations about DSS. Some organisations and scholars began to develop and research DSS which became characterised as *interactive* computer based systems which *help* decision makers utilise *data* and *models* to solve *unstructured* problems. According to Sprague and Watson (1974), the unique contribution of DSS resulted from these key words. However, a serious definitional problem arose in that the words had certain 'intuitive validity' – any system that supports a decision (in any way) is a "Decision Support System". This term had such an instant intuitive appeal that it quickly became a 'buzz word' (Sprague and Watson, 1996). However, neither the restrictive nor the broad DSS definition provided guidance for understanding the value, the technical requirements or the approach for developing and implementing a DSS. For a discussion of DSS implementation, see for example, Averweg (1998).

Development of the DSS Field

According to Sprague and Watson (1996), DSS evolved as a 'field' of study and practice during the 1980s. During the early development of DSS, several principles evolved. Eventually, these principles became a widely accepted "structural theory" or framework – see Sprague and Carlson (1982). The four most important of these principles are summarised:

- **The DDM Paradigm**
  The technology for DSS must consist of three sets of capabilities in the areas of **d**ialog, **d**ata and **m**odelling and what Sprague and Carlson call the DDM paradigm. The researchers make the point that a good DSS should have *balance* among the three capabilities. It should be *easy to use* to allow non-technical decision makers to interact fully with the system. It should have access to a *wide variety of data* and it should provide *analysis and modelling* in a variety of ways. Sprague and Watson (1996) suggest that many early systems adopted the name DSS when they were strong in only one area and weak in the other. Figure 1 shows the relationship between these components in more detail and it should be noted that the models in the model base are linked with the data in the database. Models can draw coefficients, parameters and variables from the database and enter results of the model's computation in the database. These results can then be used by other models later in the decision-making process.

Figure 1 also shows the three components of the dialog function wherein the database management system (DBMS) and the model base management system (MBMS) contain the necessary functions to manage the database and model base respectively. The dialog generation and management system (DGMS) manages the interface between the user and the rest of the system.

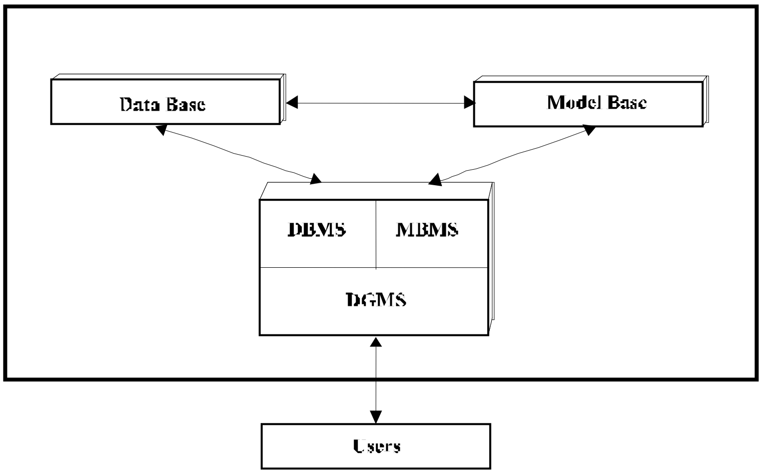

Figure 1: The Components of DSS
(Source: Adapted from Sprague and Watson, 1996)

- **Levels of Technology**
  Three levels of technology are useful in developing DSS and this concept illustrates the usefulness of configuring *DSS tools* into a *DSS generator* which can be used to develop a variety of *specific DSS* quickly and easily to aid decision makers – see Figure 2. The system which actually accomplishes the work is known as the *specific DSS*, shown as the circles at the top of the diagram. It is the software/hardware that allow a specific decision maker to deal with a set of related problems. The second level of technology is known as the *DSS generator*. This is a package of related hardware and software which provides a set of capabilities to quickly and easily build a specific DSS. The third level of technology is *DSS tools* which facilitate the development of either a DSS generator or a specific DSS.

  While new technologies such as World Wide Web ('Web') browsers and data warehouses have emerged since Sprague and Watson's (Sprague and Watson, 1996) conceptual framework, nowadays the framework is still relevant.

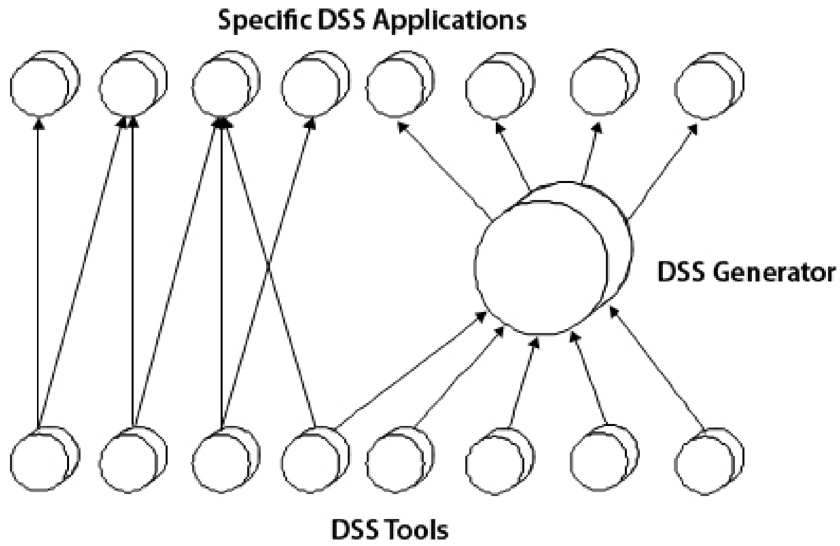

Figure 2: Three Levels of DSS Technology
(Source: Adapted from Sprague and Watson, 1996)

- **Iterative Design**
  Instead of the traditional development process, DSS require a form of iterative development which allows them to evolve and change as the problem or decision situation changes. They need to be built with short, rapid feedback from users thereby ensuring that development is proceeding correctly. In essence they must be developed to permit change quickly and easily.

- **Organisational Environment**
  The effective development of DSS requires an organisational strategy to build an environment within which such systems can originate and evolve. The environment includes a group of people with interacting roles, a set of software and hardware technology, a set of data sources and a set of analysis models.

The IS called DSS are not all the same. DSS differ in terms of capabilities and targeted users of a specific system and how the DSS is implemented and what it is called (Power, 2003a). Some DSS focus on data, some on models and some on facilitating collaboration and communication. DSS can also differ in terms of targeted users *e.g.* a 'primary' user or 'generic' users.

Holsapple and Whinston (1996) identified five specialised types of DSS:

- text-oriented;
- database-oriented;
- spreadsheet-oriented;
- solver-oriented; and
- rule-oriented.

Donovan and Madnick (1977) classified DSS as *ad hoc* DSS or institutional DSS. An *ad hoc* DSS supports problems that are not anticipated and which are not expected to reoccur. An institutional DSS supports decisions that reoccur. Hackathorn and Keen (cited in Power, 2003a) identified DSS into three interrelated categories:

- personal DSS;
- group DSS; and
- organisational DSS.

DSS frameworks
Power (2003a) suggests that the following DSS frameworks help categorise the most common DSS currently in use:

- **Communications-driven DSS**. These systems are built using communication, collaboration and decision support technologies;
- **Data-driven DSS**. These systems analyse large "pools of data" found in major organisational systems and they support decision-making by allowing users to extract useful information that was previously buried in large quantities of data. Often data from various transactional processing systems (TPS) are collected in data warehouses for this purpose. Online analytical processing (commonly known as OLAP) and data mining can then be used to analyse the data;

- **Document-driven DSS.** These systems integrate a variety of storage and processing technologies to provide complete document retrieval and analysis;
- **Knowledge-driven DSS**. These systems contain specialised problem-solving expertise wherein the 'expertise' consists of knowledge about a particular domain (and understanding of problems within that domain) and 'skill' at solving some of those problems; and
- **Model-driven DSS**. Early DSS developed in the late 1970s and 1980s were model driven as they were primarily standalone systems isolated from major organisational IS that used some type of model to perform "what if" and other kinds of analysis. Such systems were often developed by end-user groups or divisions not under central IS control (Laudon and Laudon, 1998). A DSS is not a black box – it should provide the end-user with control over the models and interface representations used (Barbosa and Hirko, 1980). Model-driven DSS emphasise access to and manipulation of a model.

Watson (2005) suggests that "I don't think that we need to find a single theory or framework. Furthermore, I don't think that we will see a single overarching theory emerge. Rather, there will be multiple theories, each one being appropriate for specific situations". Despite all the rapid developments of the late 1980s, 1990s and early 2000s, DSS as a field is now at a crossroads. Some functions that were once considered part of DSS now appear to be migrating to other areas. For example, Watson (2005) suggests that there is an increasing trend to integrate and embed decision support applications into operational systems (*e.g.* fraud detection system embedded in credit card processing).

1.5 Future trends

In future, it is envisaged that traditional DSS applications will be extended to a larger number of potential applications where the data required is only an interim stage or a subset of the information required for the decision. This will require the construction of DSS where the end-user can concentrate on the variables of interest in their decision while "other" processing is performed without the need of extensive end-user interaction. Some future trends for DSS are suggested:

- organisations that consolidate there is into a single environment reduce administration and license costs. By consolidating organisational data into a Web visualisation application, will facilitate better decision support;
- all organisations use metrics and key performance indictors to undertaken business and remain competitive. With the advent of Web-based technologies (*e.g.* portal technologies), a decision support portal will be able to present key information to the right audience;
- in future all data collection and analysis will be automated. This will "free up" domain experts from verifying the validity of data from TPS and data warehouses allowing them to *act* on the information from DSS instead;

- there will be an increase in visualised information in context with user-centric displays. By having the most recent data correlated and aggregated, will allow for better decisions and which are more relevant to a user's current conditions;
- there will be a surge to use advanced display techniques to highlight key issues. Consequently the design of future DSS interfaces will receive greater prominence since the interface should bring attention to the most important areas almost immediately; and
- decision support technology will continue to broaden to include monitoring, tracking and communication tools to support the overall process of unstructured problem solving. The broadening of this technology will be as a result of an increased availability of mobile computing and communication.

1.6 Conclusion

DSS continue to impact decision-making in organisations and this is largely dependent on the nature of the application. In order that optimal solutions may be identified, more alternatives may need to be explored and some decisions may need to be automated. The Internet and the Web have accelerated developments in decision support and decision-making and nowadays provide a new research focus area for DSS development and implementation.

1.7 References

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