# DECISION SUPPORT SYSTEMS:

# CRITICAL SUCCESS FACTORS FOR IMPLEMENTATION

**Udo Richard Franz Averweg**

**A Research dissertation submitted in complete fulfilment for the requirements of the degree of Master of Technology in Information Technology in the Department of Computer Studies, M L Sultan Technikon, Durban, South Africa.**

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## Preface

This work was carried out at the Department of Computer Studies, ML Sultan Technikon, Durban, South Africa. The co-supervisors of this research project were Doctor Stuart W. Melville (until his untimely demise on 02 August 1997) and Professor Geoff J. Erwin. The research was conducted during the period March 1996 to December 1998.

These studies represent original work by the author and have not been submitted in any form to any other tertiary institution. Where use has been made of the works of others, it has been duly acknowledged in the text.

Some of the material in this study has been internationally recognised and used as follows:

- on 07 August 1998 in a presentation to Organisational Management Masters degree students at the University of Natal, Durban;
- on 16 October 1998 as a guest lecturer to second and third year Information Systems and Technology students at the University of Durban-Westville, Durban;
- for a paper presented at The South African Institute of Computer Scientists and Information Technologists (SAICSIT) Conference in Gordons Bay, South Africa during the period 23-24 November 1998 (Averweg and Erwin, 1998); and
- in an internationally refereed and accepted paper for presentation at the 32nd Hawai'i International Conference on System Sciences (HICSS-32) to be held on the island of Maui during the period 05-08 January 1999 (Averweg and Erwin, 1999). (Seventeen full paper submissions were made to the "Information Technology in Developing Countries" mini-track. Only seven papers were judged suitable for acceptance. The reviewers were "from all over the world - US, Europe, Africa, Asia" (Davison, 1998)).

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Finally, I should like to thank my family and many friends for enduring the less glamorous side of this dissertation.

Udo Averweg

December 1998

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## Dedication

*To my father, Walter, for his continued support throughout my life*

## Abstract

*Decision Support Systems (DSS) are interactive computer-based systems developed to support managers in complex tasks requiring human judgment. DSS utilise data, provide an easy user interface and allow for the decision maker's own insights.*

*This study explored some of the issues that need to be addressed by organisations embarking on a DSS implementation program in KwaZulu-Natal, South Africa.*

*Twenty seven KwaZulu-Natal organisations which have implemented DSS were identified and surveyed. Of these, some were successful whilst others less successful in their implementation. From the available literature, nine critical success factors (CSFs) were identified; namely, user involvement, top management support, user training, information source, level of managerial activity being supported, user information satisfaction, relative use, perceived utility and goal realisation.*

*Evidence for the existence of five of the nine CSFs namely, user involvement, top management support, user training, relative use and perceived utility as extracted from the literature, was found. Furthermore, this dissertation reports several major findings: (1) critical success factors may be absent and yet an organisation's DSS may be successful; and (2) an additional critical success factor namely, appropriate DSS tools, was identified.*

**Keywords:** *Critical success factors, DSS, Top Management Support, User Information Satisfaction*

**Computing Review Categories:** *H.4.2, K.6.1*

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# Chapter 1

## INTRODUCTION

### 1.1 Introduction to Decision Support Systems (DSS)

Information is a crucial component in today's society. With our shrinking world, accelerated communications and growing interests, information relevant to a person's life, work and recreation has exploded. There are some who believe that the information explosion has backfired, leaving us stranded between *mere* facts and *real* understanding (Sauter, 1997).

The surge in information technology during the latter part of the twentieth century has "forced" organisations to meet its challenges (Garrity and Sanders, 1998). Recent years have witnessed an increase in the use of information technology which has permeated organisations at every level (Curtis, 1998). Information systems are essential to the operation and management of today's organisations (Nickerson, 1998). The use of information technology to support decision making and problem solving continues to advance (Sprague and Watson, 1996).

Although executives have become computer literate, few of them have "mastered" the questions of what information they need, when they need information and in what form they need information (Sauter, 1997). Peter Drucker (1997) notes in *Wall Street Journal* that executives will need better information in the future if their organisations are to be competitive: more information is not profitable unless it is relevant information. As Turban (1995) states, executives are recognising that information systems allow organisations to compete and sometimes even to survive. As competition increases, **Decision Support Systems** (DSS) have started to assist organisations in rapid response to time critical situations (Gray, 1994). DSS are interactive, flexible and adaptable computer-based information systems specially developed for supporting the solution of non-structured management problems for improved decision making (Turban, 1995). DSS are designed to help organisational makers make decisions (Hoffer *et al*, 1999).

Nobel Laureate economist, Herbert Simon, states in *Scientific American* (1995) that "what information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate that attention efficiently among the overabundance of information sources that might consume it". Clearly as the amount of information increases, so does the need for filtering processes that help decision makers find that which is most important and meaningful (Sauter, 1997).

Information is data which has been processed and is meaningful to a user. Useful information is critical to decision-makers of an organisation (*i.e.* a user) but it is often difficult to define exactly what information is. The term *information* is an imprecise term as it has been used to refer variously to raw data, organised data, the capacity of a communication channel and anything that is in between these categories. The first step in determining the usefulness of information is to contrast it with data (Sauter, 1997). The term *data* represents things known or assumed. In contrast the term *information* means acquired knowledge. While this seems to be a subtle difference, Sauter (1997) indicates that this is an important one because it represents the difference between a computer application and decision support. In general terms, raw facts and figures represent *data* and processed facts represent *information*.

A system is defined as an organised collection of components, designed and coordinated for the purpose of filling some defined role (Holsapple and Whinston, 1996). A system is comprised of interdependent components which are unified by design to accomplish one or more objectives (see Kast and Rosenzweig, 1972; and Luchsinger and Dock, 1977). Since work is often accomplished by individuals working in concert with machines, the principal focus is on the quality of the interface and the information provided to aid the worker in accomplishment of his task. For this perspective, Garrity and Sanders (1998) define a *system* in the narrow sense as the software and the computer interface.

Since information is data which has been processed (Hoffer *et al*, 1999), it follows that some data has to be collected, transmitted, processed and then stored. To be meaningful to users, the information must be retrieved and distributed to the users. Smit and Cronjé (1995) define information as processed data that is relevant to a manager in making decisions. Erwin and Blewett (1998) state that information is data that is used to *inform* someone because information is data with meaning. The users belong to a system known as the "organisation" and one of the components (or subsystems) of an organisation is the "information system". The components of the information system are people, software, hardware, procedures and data. The organisational system therefore collects, transmits, processes, stores data and retrieves and distributes information to various users in an organisation. Clearly, information systems (IS) produce information that support the operation and management functions of an organisation.

In this research, focus will only be on computer based information systems. The ensuing chapters will discuss systems classified by types of decision or by user (*e.g.* a transaction processing system, management information system, decision support system, *etc*). Specific detailed research was undertaken on DSS. Informal IS that exist in all organisations, such as the "grapevine", are excluded from this research. Formal specialised IS exist in some organisations (*e.g.* a process-control system supervising a chemical process), but these too are excluded from this research.

In 1513, Niccolo Machiavelli made the following observation about systems in general:

> There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new system. For the initiator has the enmity of all who would profit by the preservation of the old system and merely lukewarm defenders in those who would gain by the new one (Biggs *et al*, 1980).

The development, operation, management and use of IS in organisations is a complex activity. Managers believe in support systems and they have some very clear opinion of the impacts of support systems in both decision making and strategic planning. Computer and related information technologies are vital features of modern IS. These technologies can become the villain of an information system rather than a benefactor if improperly installed and controlled thereafter. As Phil Mostert, CEO of the world's largest gold refinery, Rand Refineries, publicly stated "the problems of IT installation are an almost universally accepted balls-up" (Financial Mail, 1998b).

As the same article indicates "chances are that those who have had installation problems dismiss them as necessary evils in the process of building an IT system".This research is a contribution to the identification of factors that must be taken into account and blended with other components (users, managers and procedures) to ensure the successful implementation of an IS. The IS focus will be solely on Decision Support Systems. The research will target the successful implementation of DSS.

## 1.2 Success Measurement

Garrity and Sanders (1998) indicate that the field of IS could certainly benefit from generally agreed upon measures of IS success. Standardised dependent measures would then allow for study replications and cross-study comparisons. However, some scholars believe that there is no holy grail of IS success and that standardisation is a fruitless endeavour. For example, Kanellis *et al* (1996) argue that success is a perspective that emerges from the social and technical interplay within an organisation. More recently, Kanellis *et al* (1998) state in broad terms that "there can be no single account of success but only different perceptions influenced by context".

IS success can be measured at multiple levels of analysis (Garrity and Sanders, 1998). At the organisational level, IS success is measured using metrics related to organisational performance (*e.g.* how a system contributes to profitability, market share and return on equity). At the function or process level, system success is measured in terms of the efficient use of resources and the reduction of process cycle times. The focus of IS success at the individual level of analysis is on systems usage and the users' perception of satisfaction and utility. The latter construct (*i.e.* at the individual level of analysis) is the theme of this research.

There are universal factors which affect the implementation success of an IS project (Jenkins, 1997). Surveys of organisations using computerised IS show that systems can be classified as successful or unsuccessful (see, for example, Addison and Hamersma, 1996). IS literature and research report on many attempts to specify the critical variables that when properly handled, "guarantee" IS success (see, for example, Kleijnen, 1979; Swanson, 1982; Chismar and

Kriebal, 1985; Hirschheim, 1985; Crowston and Treacy, 1986; Goodhue, 1986; Iivari, 1987; Sanders, 1987; Ginzberg and Zumd, 1988; Straub, 1989; Melone, 1990; De Lone and McLean, 1992; and Shirani *et al*, 1994). As Garrity and Sanders (1998) indicate, specifying a dependent variable is difficult because of the many theoretical and methodological issues involved in measuring IS success. Delone and McLean (1992) point out that a large number of IS success measures exist because of the many ways information and IS can be viewed. Dependent variables include user involvement, user attitudes and cognitive style, top management support, budgets, user education and training, resource availability, psychological climate in the organisation, organisational maturity and organisation size. For a discussion of dependent variables of IS success, see Ishman (1998). Any single variable may contribute to the failure of a system but no variable alone determines success. There can be no single account of success (Kanellis *et al*, 1998). Critical success factors are those key areas where "things must go right" for an organisation to flourish (Bullen and Rockart, 1981). The outcome is usually the result of complex interplay among the variables that determine the starting point (the development process) and the resulting system. A unique combination of variables is peculiar to each organisation.

The development of an information system is not only a technological project: it has managerial, organisational and behavioural implications. Each system must therefore be adapted to the relevant environmental, organisational and personal situations. Many information systems have failed because of concentrating solely on the technical aspects when organisational behavioural problems have been overlooked (Lucas, 1995). Success is a perspective that emerges from the technical and social interplay within organisations (Kanellis *et al*, 1998).

## 1.3 The Problem and its Setting: Critical Success Factors for DSS

### 1.3.1 Statement of the Problem

The successful implementation of decision support systems is a function of many factors (Turban, 1996). The purpose of this study is to extract those critical success factors (CSFs) which have been previously identified by researchers and to establish whether they are in existence in organisations in KwaZulu-Natal, South Africa which have implemented DSS.

## 1.4 Goals of the Research

### 14.1 Subgoal one

The first subgoal of the research is to extract the CSFs associated with the DSS implementation models of Guimaraes, Igbaria and Lu (1992) and Kivijärvi and Zmud (1993).

### 14.2 Subgoal two

The second subgoal is to identify the factors whose presence in an organisation would indicate the existence of a specific CSF from subgoal one. These factors are called "evidence items" since they are pieces of evidence that point to the presence of a CSF.

### 14.3 Subgoal three

The third subgoal is to design and administer a questionnaire which seeks to document the presence/absence of the evidence items in subgoal two.

### 14.4 Subgoal four

The fourth subgoal is to analyse the evidence items collected by questionnaire and to establish which of the CSFs identified in subgoal one is found in successful DSS organisations in KwaZulu-Natal, if any.

### 14.5 Subgoal five

The fifth subgoal is to identify whether any potentially new CSFs are indicated as existing in successful DSS organisations in KwaZulu-Natal.

### 14.6 Subgoal six

The sixth subgoal is to make recommendations regarding future DSS implementations in KwaZulu-Natal organisations.

## 1.5 Scope and Delimitations

This study will explore some of the non-technical information system issues of organisations which have embarked on DSS programs. The scope of this research will be limited to existing DSS in organisations in the Durban Metropolitan region, KwaZulu-Natal (KwaZulu-Natal is one of the nine provinces in South Africa). No attempt will be made to classify or report on the relative DSS implementation success (or failure) between these organisations. It is acknowledged that some organisations may have implemented more than one DSS and in those cases, for this study, only the latest DSS implementation will be considered. See section 1.6 below regarding the stages of organisational assimilation of technology.

## 1.6 Assumptions

Computer applications are part of waves of technology (Erwin and Blewett, 1998). For each wave, once it arrives there is often a reasonably predicted series of steps by which the technology associated with each wave becomes comfortable within the organisation. This series of steps constitutes the process of organisational assimilation of technology. The four stages of organisational assimilation of technology are: initiation, proliferation, control and maturity. For a discussion of each of these stages, see McNurlin and Sprague (1989).

No attempt has been made in this research to position each organisation at one of the four stages of organisational assimilation of technology. The presence of these waves of technology is assumed as applying across the information systems of each organisation, including their usage of DSS.

## 1.7 Factors Influencing Acceptance of Computer Technology

One factor contributing to the acceptance of DSS technology is that desktop computing has made technology easier to use and portable (Sauter, 1997). With today's desktop computers, data can be downloaded and analysed at any time the decision maker wishes to do so. With laptop technology data can be processed anywhere and at anytime. The computer is therefore ready when the decision maker is ready and not vice versa. It is assumed that this information technology will continue to be available.

The second factor is that there will be continued development of friendlier software packages, even to novice users. One will no longer need to know the special "Job Control Language" and write in a specialised language in order to access data on a computer. Instead one can import data into a spreadsheet package and begin to look at trends, graphs and inter-relationships simply by using a menu. This friendliness is a feature that users have come to expect (and it is assumed) will continue to expect in the future.

The improvement in the degree of friendliness of software has been a factor which has been instrumental in the contribution to the acceptance of DSS. Many CEOs and high-level managers have been exposed to computers either at the office or at home and with this continuing trend, it is assumed that in the future they are less likely to fear their use in the decision-making process. As early as 1988, a practical grasp of computer-based decision support has been reported as essential for aspiring managers (Zuboff, 1988).

These three factors clearly contribute to the acceptance of technology but a fourth factor is the one pushing the continued use of DSS technology: decision makers are using DSS because the cost of not using the technology is getting high (Sauter, 1997).

It is obvious that both the amount of information and the number of ways of getting information have increased substantially. The ability to analyse data and react quickly is the driving force behind some of today's most successful corporations (Financial Mail, 1998a). Clearly, if the future success of organisations will be through the astute use of appropriate information, then the future of management information systems will be the design and implementation of DSS that facilitate intelligent uses of appropriate information. As South African Airways' CEO, Coleman Andrews III said, "when decisions have to be made, they should be based on the best available information" (Sunday Times, 1998).

## 1.8 Research Method

When undertaking research, it is important to make use of a structured research methodology to ensure that the research has integrity, *i.e.* that the research is reliable, valid and can be reproduced (Remenyi and Williams, 1995).

Melville and Goddard (1996) indicate that there are two fundamentally important criteria for instruments: reliability and validity. For results to be accepted they must be reproducible and this is particularly true of laboratory experiments (Squires, 1985). According to Leedy (1989), a research methodology is "an operational framework within which the facts are placed so that their meaning may be seen more clearly".

Remenyi and Williams (1995) suggest three approaches which are appropriate for the scientific acquisition of knowledge in the study of IS:

- passive observation;
- uncontrolled intervention; and
- deliberate intervention.

Uncontrolled intervention involves observing the effect of a major change in a driving variable on one or more dependent variables. Observation of deliberate intervention also involves observing the effect of a major change in a driving variable on one or more dependent variables; however, in this case the researcher deliberately brings about the change in the driving variable. For a detailed discussion of uncontrolled intervention and deliberate intervention, see Remenyi and Williams (1995).

According to these researchers, passive observation research process is the most commonly used approach in the study of IS and is the one adopted herein. Passive observation is defined as when the researcher draws on conclusions from information collected during interviews, from reports and by administering questionnaires. The steps in this research were:

1. Literature Review;
2. Assessment of the Established Theory;
3. Theoretical Conjecture;
4. Hypothesis or Empirical Generalisation;
5. Data Collection Strategy;
6. Measuring Instrument (*e.g.* Likert-type questionnaire);
7. Sampling (*e.g.* snowballing technique);
8. Testing and Analysis (*e.g.* Item Analysis, Pearson's product-moment coefficient of linear correlation and Cronbach's Alpha); and
9. Confirmation of Theoretical Conjecture and development of Fuller and Refined Theory.

A questionnaire was developed to establish whether the extracted CSFs (see Subgoal one) for DSS implementation could be identified in the organisations which participated in the survey. A series of structured interviews was conducted at the organisation's premises. Interpretation of the results was based on the answers as provided. This was supplemented by the researcher's interpretation of the responses to the open-ended questions. The results are summarised and the findings reported.

## 1.9 Importance of the Research: Towards successful DSS Implementation

From an international perspective, Turban (1995) suggests that more research should be directed towards the quantification of "successful DSS implementation". He indicates that unless there is a better definition and measurement of the success factors it will be difficult to develop good research and meaningful implementation strategies. This research is an attempt to add to the universal understanding of successful DSS implementations and to suggest guidelines to organisations in KwaZulu-Natal prior to embarking on DSS implementation programs.

Internationally recognised DSS researchers were approached regarding the research topic of CSFs for DSS implementation. They were asked whether such research was relevant in the IS arena. The enquiry elicited the following responses: Ralph Sprague Jr. (1998) "it sounds like a very good project" and Pirkko Walden (1998a) states "you have a very interesting research going on". In view of the lack of research in this field in the South African environment, this fresh approach now seeks to establish from the literature survey, whether the identified CSFs for DSS implementations are found in KwaZulu-Natal organisations.

## 1.10 Literature Survey

A number of special interest groups exist under the auspices of the Computer Society of South Africa (CSSA). In answer to a query from the author, the CSSA declared "that there is not a DSS special group existing within the Computer Society of South Africa" (du Toit, 1998). A database search (Nexus Database System) undertaken during June 1998 by the South African Human Sciences Research Council, Centre for Science Development (CSD), reveals that whilst research has been undertaken in the fields of CSFs for gaining competitive advantage using IS ((Solanki, 1995), CSFs for Expert Systems (Gold, 1989) and CSFs for Executive Information Systems (Steer, 1995; and Chilwane, 1996)), it appears that no registered research has been undertaken on **CSFs for DSS Implementations** (Terblanche, 1998). Currently, however, there is research being undertaken on DSS. See, for example, Breen (1998) and Badenhorst (1998). A search in the South African Computer Journal (ISSN 1015-7999), also reflects an absence of DSS literature.

On 21 October 1998 an online SABINET search (Internet URL http://www.sabinet.co.za) of the 57,131 records in South African National Bibliography (SANB) database and the 65,580 records in the Union Catalogue of Theses and Dissertations (UCTD) database revealed ten (SANB: 3 and UCTD:7) South African DSS research publications. See Figure 1.1.

There is also a recent publication which deals with the factors which impact on the appropriateness of Decision Support Systems in the current South African context (Scholtz, 1996). CSSA President and Director of the University of Cape Town Centre for Information Systems at the Graduate School of Business, Jonathan Miller (1997), states "I don't know of any recent studies on the topic in South Africa". From the available literature, there is no evidence that an attempt has been made to research CSFs for DSS implementations in South African organisations.

**Figure 1.1 South African DSS research publications**

| Data-base | Title of Publication | Institution | Reference |
|---|---|---|---|
| UCTD | Top Management Perspectives of Decision Support Systems | University of the Witwatersrand | Hough, P.K., 1984 |
| UCTD | The Use of Decision Support Systems in some Organisations | University of the Witwatersrand | Schuster, T.L., 1985 |
| UCTD | Using Management Decision Support Systems - an Experimental Investigation of the Role of Attitude, Locus of Control and Nonprocedural design | University of South Africa | Finnie, G.R., 1986 |
| UCTD | Behavioural Factors affecting the Implementation of Decision Support Systems | University of the Witwatersrand | Dos Santos, M.A.O., 1986 |
| UCTD | Decision Support Systems for Solving discrete Multicriteria decision-making Problems | University of Cape Town | van Dyk, T. van Z., 1992 |
| SANB | The Freshwater requirements of Estuarine Plants incorporating the Development of an Estuarine Decision Support System - Volume 1 | University of Port Elizabeth | Adams, J.B. and Bate, G.C., 1994 |
| SANB | The Freshwater requirements of Estuarine Plants incorporating the Development of an Estuarine Decision Support System - Volume 2 | University of Port Elizabeth | Adams, J.B., 1994 |
| SANB | Decision Support Systems in Health Care | SA Medical Research Council | Ittmann, H.W., Walus, Y.E. and Hanmer L.A., 1995 |
| UCTD | The use of Decision Support Systems in Motor Insurance Underwriting | University of the Witwatersrand | Nyezi, G.T., 1995 |
| UCTD | Personal Decision Support Systems for Small Businesses | University of the Witwatersrand | du Toit, E.C., 1996 |

On 27 November 1998, the E G Malherbe Library at the University of Natal, Durban (UND) undertook a database (part of OnLine Computer Library Centre (OCLC) First Search and SABINET) literature search of published DSS journal articles (Mitha, 1998). Using the search strings of "decision support systems" and "success", nine matching records ("hits") were found in the Microcomputer Abstracts database. Using the identical search strings in the Applied Science and Technology Abstracts database, nineteen hits were found. Using the search string of "decision support systems" in the British Library Inside Information database, seven hits were found. For a summary of this database literature search, see Figure 1.2.

**Figure 1.2 Summary of the Database Literature Search undertaken by UND on 27 November 1998**

| Database | No of Hits |
|---|---|
| Microcomputer Abstracts (OCLC First Search) | 9 |
| Applied Science and Technology Abstracts (OCLC First Search) | 19 |
| British Library Inside Information (SABINET) | 7 |

In the case of the Microcomputer Abstract and British Library Inside database records, no topics related to CSFs for DSS implementation. For the Applied Science and Technology Abstracts database records, seven subject titles were related to CSFs for DSS implementation. See Figure 1.3.

**Figure 1.3 Applied Science and Technology Abstract database records: Subject Titles related to CSFs for DSS implementation**

| Title of Publication | Standard No | Reference |
|---|---|---|
| Design and Implementation of a Decision Support System for Academic Scheduling | 0378-7206 | Kassicieh, S.K. , Burleson, D.K. and Lievano, R.J., 1986 |
| Characteristics and Implementation of Decision Support | 0378-7206 | Casimir, R.J., 1988 |
| Group Decision Support Systems: Factors in a Software Implementation | 0378-7206 | Sutherland, D. and Crosslin, R., 1989 |
| Personal DSS Success in Small Enterprises | 0378-7206 | Raymond, R. and Bergeron, F., 1992 |
| A Survey of Rural Small Business Computer Use: Success Factors and Decision Support | 0378-7206 | Lai, V.S., 1994 |
| An Experimental Investigation of Factors Influencing Predicted Success in DSS Implementation | 0378-7206 | Palvia, S.C. and Chervany, N.L., 1995 |
| Variation in Success of Implementation of a Decision Support/Finite Scheduling System | 0897-8336 | Schmahl, K.E., 1996 |

From the literature survey, little research has been undertaken on the CSFs for DSS implementation in South Africa. With the absence of any significant research efforts in this topic, this research begins to fill the gap with a field study of the CSFs for DSS in KwaZulu-Natal.

## 1.11 Overview of the Research Structure

Chapter 2 gives an overview of the framework for decision support and it discusses classical decision making processes. The evolution of several widely accepted DSS principles is reviewed.

DSS, from an historical perspective is discussed and a working definition is suggested. The evolution of DSS in the academic and research fields and the emergence of DSS conferences, are summarised. Important DSS development and trends are reviewed and the current status of DSS is discussed.

Chapter 3 discusses the evolution of computerised aids, notes some differences between MIS and DSS and looks at the DSS-ES connection. DSS distinguishing characteristics and capabilities and the derived benefits are then discussed. Integrating EIS, DSS and ES is then reviewed. The role of artificial intelligence in DSS is discussed. The components of DSS, the classification of DSS and their support are noted in Chapter 4. DSS construction issues are identified and then the DSS development process is reviewed. Finally an evaluation of DSS success and the impact on management is made.

Chapter 5 discusses critical success factors in management with specific reference to IS and DSS. Chapter 6 identifies factors affecting management support system implementations. From the literature survey, various success measures for DSS implementations are identified and discussed. Organisational factors which are important to successful implementation are discussed. An overview of existing implementation strategies is given.

In Chapter 7 two tested frameworks for the implementation of DSS are discussed. The CSFs from these models are combined and the associated evidence items for each CSF are identified. The climate for undertaking DSS implementation research in the South African environment is discussed. Chapter 8 discusses the methodologies used in previous DSS studies and the methodology used in this research. Theoretical conjecture and empirical generalisations are made. The measuring instrument chosen for this research is described. The pilot study, the design of the structured interviews, the selection of the respondents and the testing analysis are then discussed.

The conduct and results of the structured interviews are reported in Chapter 9. The findings are summarised and possible explanations for these results are then discussed. Chapter 10 reports the conclusions of the research and implications for organisations wishing to embark on DSS implementation programs in South Africa. The limitations of this research and further areas for exploration are noted.

## 1.12 Summary

In this chapter, a review of information as a vital resource for organisations was given. The concept of computer-based information systems was introduced with the focus on Decision Support Systems.

The problem statement for this research, in establishing whether the previously identified CSFs are in existence in organisations in South Africa which have implemented DSS, was discussed. The goals of this research and the scope and delimitations were identified. Assumptions were stated and an overview of the research method was given. The importance of the research in the South African context was discussed: to assist organisations in KwaZulu-Natal by suggesting guidelines prior to embarking on DSS implementation programs. Finally, an overview of the ensuing chapter topics was given.

# Chapter 2

## BACKGROUND TO DECISION SUPPORT

### 2.1 Introduction

Computerised systems are assisting managers in building, analysing and utilising models, charts, graphs; managing projects and time and electronically writing and transmitting memoranda and reports. Furthermore, managers can perform these tasks by themselves on their personal computers without waiting for the IS department to undertake for them on their behalf. The manager is discovering that the computer is like a very reliable staff assistant; it works endlessly without pay, complaints, mistakes or criticisms of other people (Turban, 1995).

Management now realises that computers are not "merely another fad". Executives are recognising that IS can provide value-added computer power to the execution of mission-critical tasks and to the business of re-engineering. Computer applications are moving from transaction processing and monitoring systems (which dominated the industry in the 1960s and 1970s) to problem analysis and solution applications in the 1990s. There is a growing trend to provide managers with IS that can assist them in their most important task-making decisions. All levels of management can benefit from the use of DSS capabilities. The highest level of support is usually for middle and upper management (Sprague and Watson, 1996).

Computer-based technologies are developed to improve the effectiveness of managerial decision making especially in complex tasks. Technologies such as DSS, group support systems (GSS), expert systems (ES), executive information systems (EIS) and artificial neural networks (ANN) exist. Even though these technologies appear as independent systems, the current trend is to integrate them among themselves and with other computer-based information systems. Since the objective of these technologies is to support the solution of management problems, their use either as independent tools or as hybrid systems, can be considered as providing management support. Turban (1995) indicates that the term management support systems (MSS) refers to the application of any of the technologies, either as an independent tool or in some form of integration to the solution of management problems. For the purposes of this study, the primary focus will be on DSS. The question of how a traditional DSS supports individual and group processes will now be discussed.

## 2.2 Decision-Making Categories

H. A. Simon is considered a pioneer in the development of human decision-making models (Ahituv and Neumann, 1990). His individual work (Simon, 1960) and his joint research with A. Newell (Newell and Simon, 1972) established the foundation for human decision-making models. His basic model depicts human decision making as a three stage process. These stages are:

- **Intelligence**. The identification of a problem (or opportunity) that requires a decision and the collection of information relevant to the decision;
- **Design**. Creating, developing and analysing alternative courses of action; and
- **Choice**. Selecting a course of action from those available. Turban (1995) states that an issue that relates to "choice" is the technique of CSFs. This will be dealt with in Chapter 5.

Decision making can be categorised as:

- Independent;
- Sequential interdependent; or
- Pooled interdependent (Keen and Scott Morton, 1978).

Independent decision making involves one decision maker using a DSS to reach a decision without the need or assistance from other managers. This form of DSS use is found occasionally. Sprague and Watson (1996) contend that it is the exception because of the common need for collaboration with other managers. Sequential interdependent decisions involve decision making at a decision point and are followed by a subsequent decision at another point. In this case the decision at one point serves as input to the decision at another point. A practical example is corporate planning and budgeting where a department formulates a plan which then serves as input to the development of the budget. Sprague and Watson (1996) indicate that DSS are frequently used in support of sequential dependent decision-making but not as frequently as pooled interdependent decision-making.

Pooled interdependent decision-making is a joint, collaborative decision-making process whereby all managers work together on the task. A group of product marketing managers getting together to develop a marketing plan is an example of this type of decision. Specialised hardware, software and processes have been developed to support pooled interdependent decision-making but for the purposes of this study, these are not explored.

## 2.3 Problems and Decision-Making Processes

Ackoff (1981) cites that there are three kinds of things that can be done about problems - they can be *resolved*, *solved* or *dissolved:*

- **Resolving**. This is to select a course of action that yields an outcome that is good enough that satisfices (satisfies and suffices);
- **Solving**. This is to select a course of action that is believed to yield the *best possible* outcome that optimises. It aspires to complete objectivity and this approach is used mostly by technologically oriented managers whose organisational objective tends to be *thrival* than mere survival; and
- **Dissolving**. This to change the nature and/or the environment of the entity in which it is embedded so as to remove the problem.

Sauter (1997) indicates that a DSS will not solve all the problems of any given organisation. The author adds, "however, it does *solve* some problems" (author's own italics).

In a structured problem, the procedures for obtaining the best (or worst) solution are known. Whether the problem involves finding an optimal inventory level or deciding on the appropriate marketing campaign, the objectives are clearly defined. Common business objectives are profit maximization or cost minimization. Whilst the manager can use the support of clerical, data processing or managements science models, management support systems such as DSS and ES can be useful at times. One DSS vendor states that facts now supplement intuition as analysts, managers and executives use Oracle DSS® to make more informed and efficient decisions (Oracle Corporation, 1997).

In an unstructured problem, human intuition is often the basis for decision-making. Typical unstructured problems include the planning of a new service to be offered or choosing a set of research and development projects for next year. The semi-structured problems fall between the structured and the unstructured which involves a combination of both standard solution procedures and individual judgment. Keen and Scott Morton (1978) give the following examples of semi-structured problems: (USA) trading bonds, setting marketing budgets for consumer products and performing capital acquisition analysis. Clearly, here a DSS can improve the quality of the information on which the decision is based (and consequently the quality of the decision) by providing not only a single solution but a range of alternatives. These capabilities allow managers to better understand the nature of the problems so that they can make better decisions.

Research by Bollojou (1996) argues that at higher organisational levels, many of the decision problems are qualitative in nature, mostly *ad hoc* and non-repetitive. He contends that there is rarely sufficient time to develop decision support systems. Rules, guidelines and the value system of the decision maker are involved in the decision making process. The application of quantitative techniques in these situations, results in many assumptions and approximations and the danger that the model differs significantly from the reality it purports to represent (Scholtz, 1996).

The decision-making process is generally considered to consist of a set of phases or steps which are carried out in the course of making a decision (Sprague and Watson, 1996). Before defining the specific management support technology of DSS, it will be useful to present a classical framework for decision support. This framework will assist in discussing the relationship among the technologies and the evolution of computerised systems.

The framework, see Figure 2.1, was proposed by Gorry and Scott Morton (1971) who combined the work of Simon (1960) and Anthony (1965).

**Figure 2.1 Decision Support Framework**

| | Type of Control | | | |
|---|---|---|---|---|
| **Type of Decision** | **Operational Control** | **Managerial Control** | **Strategic Planning** | **Support Needed** |
| **Structured** | ① Accounts receivable, order entry | ② Budget analysis, short-term forecasting, personnel reports, make-or-buy analysis | ③ Financial management (investment), warehouse location, distribution systems | MIS, operations research models, transaction processing |
| **Semi-structured** | ④ Production scheduling, inventory control | ⑤ Credit evaluation, budget preparation, plant layout, project scheduling, reward systems design | ⑥ Building of new plant, mergers and acquisitions, new product planning, quality assurance planning | DSS |
| **Unstructured** | ⑦ Selecting a cover for a magazine, buying software, approving loans | ⑧ Negotiating, recruiting an executive, buying hardware | ⑨ R&D planning, new technology development, social responsibility planning | DSS, ES, neural networks |
| Support Needed | MIS, management science | Management science, DSS, ES, EIS | EIS, ES, neural networks | |

(Source: Adapted from Turban *et al*, 1999)

The details of this framework are:

The left hand side of the table is based on Simon's notion that decision-making processes fall along a continuum that ranges from highly structured (sometimes referred to as *programmed*) to highly unstructured (*non programmed*) decisions. **Structured** processes refer to routine and repetitive problems for which standard solutions already exist. **Unstructured** processes are "fuzzy" for which no cut-and-dried solutions exist. Decisions where some (but not all) of the phases are structured are referred to as **semi-structured** by Gorry and Scott Morton (1971).

The second half of this framework (upper half of Figure 2.1) is based on Anthony's (1965) taxonomy which defines three broad categories that encompass all managerial activities:

- **Strategic Planning**. The long-range goals and the policies for resource allocation;
- **Management Control**. The acquisition and efficient utilisation of resources in the accomplishment of organisational goals; and
- **Operational Control**. The efficient and effective execution of specific tasks.

Anthony and Simon's taxonomies are combined in a nine-cell decision support framework in Figure 2.1 above. The right-hand column and the bottom row indicate the technologies needed to support the various decisions. For example, Gorry and Scott Morton (1971) suggest that for the semi-structured and unstructured decisions, the conventional MIS and management science approaches are insufficient. They proposed the use of a supportive information system, which they labelled a **decision support system** (DSS). Expert systems (ES), which were only introduced several years later, are most suitable for tasks requiring expertise.

The more structured and operational control-oriented tasks (cells 1, 2 and 4) are performed by low-level managers. The tasks in cells 6, 8 and 9 are the responsibility of top executives. This means that DSS, EIS, neural computing and ES are more often applicable for top executives and professionals tackling specialised, complex problems.

A DSS is typically developed to address a specific problem (or opportunity) which has been identified. Therefore, Sprague and Watson (1996) indicate that it is often unnecessary for a DSS to support the intelligence phase of Simon's model (see section 2.2), especially for *ad hoc* DSS, where the DSS is created in response to the specific problem. In the case of institutional DSS, which provide on-going decision support, a DSS may trigger an exception report which signals the need to address a problem. A comparison of the characteristics of institutional DSS and *ad hoc* DSS is discussed later in section 4.5.2.

The true test of a DSS is its ability to support the design phase of decision-making as the real core of any DSS is the model base which has been built to analyse a problem or decision. The primary value to a decision maker of a DSS is the ability of the decision maker and the DSS to explore the models interactively as a means of identifying and evaluating alternative courses of action. This is of tremendous value to the decision maker and represents the DSS's capability to support the design phase (Sprague and Watson, 1996). For the DSS choice phase, the most prevalent support is through "what if" analysis and goal seeking.

In terms of support from DSS, the choice phase of decision-making is the most variable. Traditionally, as DSS were not designed to make a decision but rather to show the impact of a defined scenario, choice has been supported only occasionally by a DSS. A practical example is where a DSS uses models which identify a best choice (*e.g.* linear programming) but generally they are not the rule.

## 2.4 Development of the DSS Field

According to Sprague and Watson (1996), DSS evolved as a "field" of study and practice during the 1980s. This section discusses the principles of a theory of DSS. The next paragraph discusses the academic research activities and conferences which led to the formation and development of the DSS field.

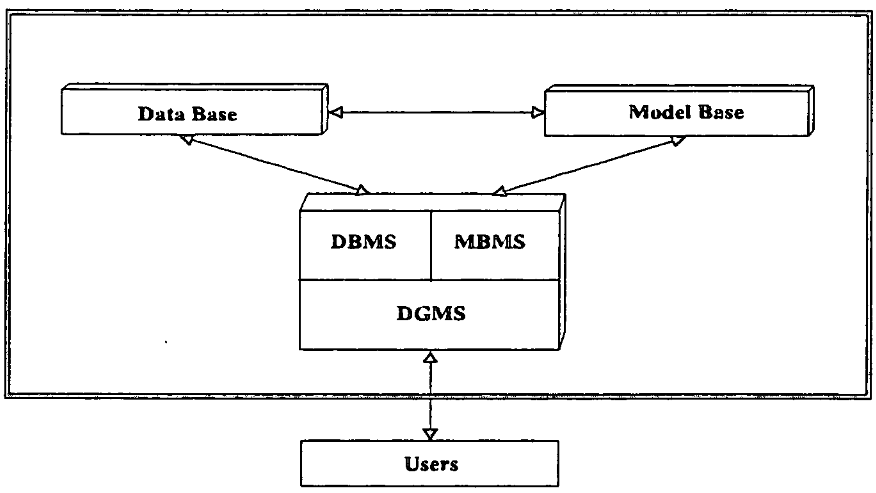
During the early development of DSS, several principles evolved. Eventually, these principles became a widely accepted "structural theory" or framework. See Sprague and Carlson (1982). The four most important of these principles are now summarised.

### 2.4.1 The DDM Paradigm

The technology for DSS must consist of three sets of capabilities in the areas of dialog, data and modelling 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) contend that many early systems adopted the name DSS when they were strong in only one area and weak in the other. Figure 2.2 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 2.2 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 data base and model base respectively. The dialog generation and management system (DGMS) manages the interface between the user and the rest of the system.

**Figure 2.2 The Components of DSS**



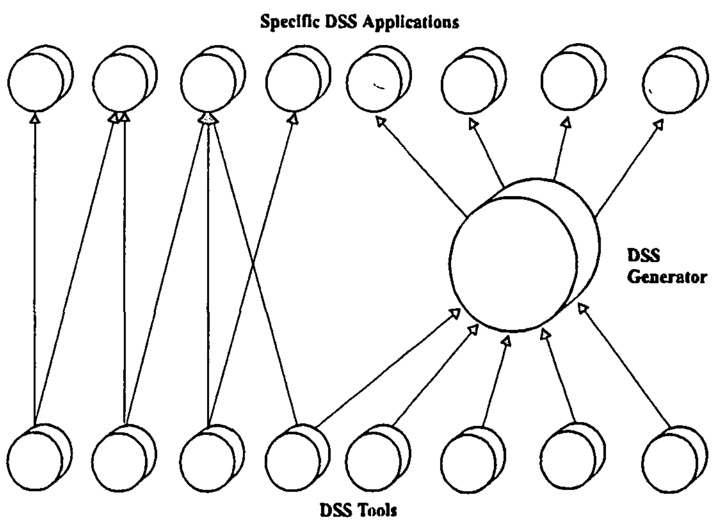

(Source: Adapted from Sprague and Watson, 1996)

Even though the DDM paradigm eventually evolved into the dominant architecture for DSS, for the purposes of this study, none of the technical aspects is explored any further. However, the components of the DSS subsystems will be dealt with in section 4.2.

### 2.4.2 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 2.3. 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.

**Figure 2.3 Three Levels of DSS Technology**




(Source: Adapted from Sprague and Watson, 1996)

DSS tools can be used to develop a specific DSS application strictly as indicated on the lefthand side of the diagram. This is the same approach used to develop most traditional applications with tools such as general purpose languages, subroutine packages and data access software. The difficulty of the approach for developing DSS is the constant change and flexibility which characterises them. The development and use of DSS generators create a "platform" or staging area from which specific DSS can be constantly developed and modified with the co-operation of the user and with minimal time and effort. These three levels of technology will be discussed in more detail in section 4.6.

### 2.4.3 Iterative Design

The nature of DSS requires a different design and development techniques from traditional batch and online systems. 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.

### 2.4.4 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.

## 2.5 DSS: Past and Present

Van Schaik (1988) refers to the early 1970s as the era of the DSS concept because in 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 over the interpretation of the notion decision support system and the origin of this notion is clear:

- **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.

Van Schaik (1988) states that this DSS definition is much too broad to provide a meaningful categorisation of available *technology* as almost anything could qualify as a DSS: from a sophisticated interactive decision modelling system through a programmable hand-held calculator to a cup of coffee.

DSS can be viewed as a third generation of computer-based applications (Sprague and Watson, 1996). First there were mainframe computers which were used mostly for transactions processing. Then, there was a growing realisation that computers and information technology (IT) could be used for purposes other than automating paper work (*e.g.* for management reporting), so the field of management systems took hold. Concurrently, assistance for decision-making was the domain of management scientists and operations researchers, who created structured models for which computers served primarily as computation engines.

This climate was fertile soil for the paper by Gorry and Scott Morton (Gorry and Scott Morton, 1971) which explored the concept of structure in decision-making. The researchers developed a now-famous matrix which showed the interaction between the level of management and the amount of structure in the decision-making done at each level. As the level of management increases from the operating management to executive levels, the decision-making process becomes semi-structured and then unstructured. The thrust of their argument was that management science models were effective for structured decision-making but decision makers needed tools and technology to assist them in dealing with semi-structured or unstructured problems. This rationale formed the basis for the work which Scott Morton undertook for this thesis on what he called "management decision systems" (Gorry and Scott Morton, 1971).

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. While Management Information Systems (MIS) provided

- scheduled reports for well-defined information needs;
- demand reports for ad hoc information request; and
- the ability to query a database for specific data,

Operations Research/Management Science (OR/MS) employed mathematical models to better analyse and understand specific problems. It was evident that each was lacking some of the attributes needed to support decision-making - attributes such as focus, development methodology, use of analytical aids, handling managerial data and dialog between user and system.

As Sprague and Watson (1996) note, 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. They contend that the definition proved restrictive enough that few actual systems completely satisfied it. They believe that some authors have recently extended the definition of DSS to include any system that makes some contribution to decision-making; in this way the term can be applied to all but transaction processing. However, a serious definitional problem arises in that the words have certain "intuitive validity"; any system that supports a decision (in any way) is a "Decision Support System". As Sprague and Watson (1996) indicate, the term had such an instant intuitive appeal that it quickly became a "buzz word". Clearly neither the restrictive nor the broad definition help much as they do not provide guidance for understanding the value, the technical requirements or the approach for developing a DSS. A further complicating factor is that people from different backgrounds and contexts view a DSS quite differently: a computer scientist and a manager seldom see things in the same way. Turban (1995) supports this stance as DSS is a content-free expression whereby it means different things to different people. He states that there is no universally accepted definition of DSS and that it is even sometimes used to describe any computerised system.

In summary, it was shown how DSS evolved at the intersection of trends in data processing and management science modelling to play an important role in the overall mission of IS in organisations. In the next sections, various DSS definitions are given and the development of DSS into a "field" of practice in education and academic research is discussed. Finally, a look is taken at important developments in DSS and also the current DSS status.

## 2.6 <u>DSS Definitions</u>

According to Freynefeld (1984), 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. In 1978, he and M. S. Scott Morton wrote 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. In their deduction they excluded operating procedures which are already pre-defined in MIS and in operational research systems where the objectives and constraints are prespecified. In these situations the outcome is essentially automatic and the need for post output judgment is therefore limited. They categorized the latter among the MIS (Van Schaik, 1988).

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

- Little (1970) who defines DSS as a "model-based set of procedures for processing data and judgments to assist a manager in his decision making (*sic*).";
- a narrow, specific definition of DSS is given by Sprague and Watson (1974) as "an interactive, computer-based system which supports managers in making unstructured decisions";
- 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";
- Keen (1981) points out that DSS "support rather than replace, judgment in that they do not automate the decision process nor impose a sequence of analysis on the user". He states that a DSS is in effect a staff assistance to whom the manager delegates activities involving retrieval, computation and reporting. The manager then evaluates the results and selects the next step in the process;

- Freynefeld (1984) defines a DSS as an interactive data processing and display system which is used to assist in concurrent decision-making processes;
- 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";
- Meador and Mezger (1984) define a DSS as an IS that is designed to help managers in private corporations and policy makers in public sector organisations solve problems in relatively unstructured decision-making environments;
- 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";
- Ahituv and Neumann (1990) define the term decision support system as an interactive, computer-based system which supports managers in making unstructured decisions;
- Hutchinson and Sawyer (1992) report that a DSS is a set of special computer programs and particular hardware which establish a sophisticated system to produce information not regularly supplied by TPS or middle management systems;
- Turban (1995) suggests a minimum working definition for DSS as "an interactive, flexible, and adaptable computer-based information system, specially developed for supporting the solution of a non-structured management problem for improved decision-making. It utilises data, it provides easy user interface, and it allows for the decision maker's own insights";
- 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; and
- 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.

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 unstructured problems) and from ideas about how the 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. Sprague (1980) states that because of the complexity of the subject, attempts at a comprehensive definition of the term are frustrating and doomed to failure. This view is underscored by Turban (1995) who indicates that previous researchers have collectively ignored the central issue in DSS; that is, "support and improvement of decision-making". Furthermore he is of the opinion that these researchers have focused on the consideration of outputs instead of the inputs. He believes that the rationale for this change in emphasis is the difficulty of measuring the outputs of a DSS (*e.g.* decision quality).

Whilst early researchers, Keen and Scott Morton (1978) offer the following description of a DSS

> "A DSS is a coherent system of computer-based technology (hardware, software and supporting documentation) used by managers as an aid to their decision-making in semi-structured decision tasks", and

Sprague (1980) articulates a definition in a "framework" paper on DSS as

> "computer-based systems that help decision makers confront ill-structured problems through direct interaction with data and analysis models",

Bidgoli (1989) contends that there are several requirements for a DSS which must underscore a definition of a DSS. These are, a DSS:

- requires hardware;
- requires software;
- requires human elements (designers and 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. (These are further discussed in section 3.4). As Turban's definition underscores both Sprague's (1980) and Bidgoli's (1989) DSS requirements, for the purposes of this study, his working definition will be used.

## 2.7 Academic Developments

By the late 1980s, Sprague and Watson (1996) contend that DSS had attained the status of a pervasive "field". American universities ran courses, faculties were engaged in research and conferences were being held at which research was presented and discussed.

### 2.7.1 DSS-XX

The International Conference on Decision Support Systems was first held in 1981 (DSS-81). The first conference was unusual because it identified four stakeholders and developed a program to bring all four together and serve them in a balanced way. The four stakeholders were:

- academics and researchers;
- DSS developers and builders;
- managers and users; and
- vendors.

In the later years, as the conference reflected a broadening perception of the topic, it was entitled "Information Technology for Executives and Managers". A recently published book contains the best papers from the conference transactions that were not previously published. See Gray (1994).

### 2.7.2 HICSS

The Hawai'i International Conference on Systems Sciences began in 1968 and in 1978 a DSS track was added. At the next conference HICSS-32 during the period

5-8 January 1999, under the track heading "Organizational Systems And Technology", a minitrack deals with the category of Decision Support Systems. At this annual conference, refereed papers are presented and published in the *Proceedings* by the IEEE Computing Society Press (*e.g.* Shriver and Sprague, 1995). A recently published book contains the best papers from recent years. See Blanning and King (1993). The real value for most participants are the discussions and interactions at the conference.

The author has co-authored a submission to HICSS-32 entitled " Critical Success Factors for Implementation of Decision Support Systems in South Africa". See Averweg and Erwin (1999).The conference paper has been refereed and accepted for inclusion in the "Information Technology in Developing Countries" minitrack and in the conference proceedings. The referees' comments include "this is clearly a well researched piece of work relating to the adoption of DSS in South Africa" and "I think this is a good contribution to the minitrack". The submitted conference paper is a subset of this research.

### 2.7.3 IFIP-WG8.3

The International Federation of Information Processing (IFIP) is organised into a series of technical committees. TC8 is devoted to information systems in organisations and in 1983, TC8 formed working group 8.3 (WG 8.3) to focus on DSS. It has world-wide activities, a European base and draws a very international clientele. It holds working conferences every other year, its most recent held during the period 13-15 July 1998 in Bled, Slovenia. *Proceedings* are published in book form by North Holland. See McLean and Sol (1986) and Sol and Vecsenyi (1991).

The first annual DSS *summit,* called the Decision Support Systems Summit, was held in Chicago, Illinois, USA during the period 18-21 October 1998. This is a new conference dedicated to business/IT fusion at the DSS frontier. The theme was that decision support is the competitive weapon in today's marketplace. The 5$^{th}$ International Conference for The International Society for Decision Support Systems (ISDSS) conference is planned for Melbourne, Australia during the period 20-23 July 1999. The next WG 8.3 meeting is currently in the planning stages for Stockholm, Sweden for summer 2000.

In order to stay abreast of ongoing advances in the decision support field, it is helpful to monitor a variety of periodicals that publish articles with DSS issues and the proceedings of conferences concerned with DSS research (Holsapple and Whinston, 1996). A recent study focused on ranking DSS-related periodicals based on more than 7,500 citations in recently published DSS articles. The top twenty journals influencing the DSS field were identified. See "An Empirical Assessment and Categorisation of Journals Relevant to DSS Research", In *Decision Support Systems*, vol 14, no 3, 1995.

DSS continues to be a ground for research and development. A 1987 survey of MIS researchers reported that DSS was one of the five most popular research themes from 1977 to 1985 (Farhoomand, 1987). A more recent report indicated that nearly one third of the researchers in MIS were engaged in DSS research (Teng and Galetta, 1990).

## 2.8 Current DSS Trends

Throughout the 1980s there have been strong advances in several areas of technology that combined to affect the field of DSS (Sprague and Watson, 1996). Organisations had hardware and software infrastructure and DSS support or development personnel. The software market has developed with several vendors basing an entire product line on DSS (*e.g.* Oracle Corporation's products Oracle Discover 3.0®, Oracle Express®, Oracle Express Server®, Oracle Express Objects®, Oracle Sales Analyzer®, etc). Trends in technology and organisations suggest even more developments (Sprague and Watson, 1996). Many DSS software vendors now have their own websites. See, for example, Cognos, Inc (URL http://www.cognos.cm/); Comshare, Inc (URL http://www.comshare.com/); Information Advantage, Inc (URL http://www.infoadvan.com); MicroStrategy (URL http://www.strategy.com); and Pilot Software (URL http://www.pilotsw.com).

provides a means to deploy decision support applications in organisations with geographically distributed sites.

Transmission Control Protocol/Internet Protocol (TCP/IP) is a file transfer protocol which allows efficient and reasonably error-free transmission between different networks. It is the standard protocol of Intranets and the Internet (Turban *et al*, 1999). In organisations that have adopted TCP/IP, Web server software (*e.g.* Netscape Commerce®) and HTML-compliant browsers for their corporate IS infrastructures, web-based DSS are practical. In these organisations, MIS staff can set up a relational DBMS server, a DSS server and Web server in a single location, build a data warehouse/DSS application using standard tools and then provide the DSS to users anywhere on the corporate Intranet or the Internet. See Saylor (1996).

## 2.10 Current DSS Status

Despite all the rapid developments of the late 1980s and 1990s, DSS as a field is now at a crossroads (Sprague and Watson, 1996). With an increased focus on special kinds of DSS, such as EIS, group DSS, ES and other knowledge-based DSS, the field seems to be fragmenting. The connotation of the term DSS in some quarters is rather narrow: specific model-intensive systems used by technical analysts. Some functions that were once considered part of DSS now appear to be migrating to other areas. Spreadsheet-based financial modelling is such an example.

Dhar and Stein (1997) contend that today there are two basic types of DSS, model-oriented and data-oriented:

- **Model-oriented 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); and
- **Data-oriented DSS**. These systems analyse large "pools of data" found in major organisational systems and they support decision making by allowing users to

advances which are making it increasingly desirable to store and manage this data. Sprague and Watson (1996) call this stored form of information a "document".

The researchers concede that this term is rather broad. It is a "chunk" of information which usually deals with a relatively limited topic or subject area. It may contain numbers, it is predominantly non-numeric including text, graphics, image, voice and video. DSS that expand the data component to gather, store, manage, manipulate and provide access to these kinds of data are called document-based DSS (DDSS).

Sprague and Watson (1996) suggest that traditional DSS failures in handling document-based data may be ascribed to the limitations and distinctive features of its underlying technology. However, these limitations may finally be dissipating as client/server networks, telecommunications, mass storage and other technologies provide the tools with which to make the information accessible. A document base also requires different access schemes and internal representations than a traditional database. AI can aid in improving the availability of technology to understand, interpret and classify the information itself. The technological demands of a DDSS must be determined in light of these and many other related areas. This will become feasible with the *integration* of new technologies in AI, groupware, object-oriented database management, information retrieval, electronic mail and representation standards. It may be known how to build many of the component pieces of the DDSS but progress is still needed on their merger.

New technology continues to affect the dialog, data and models components discussed in section 2.4. As Sprague and Watson (1996) cite, icon-based, touchscreen systems provide new options for directing the system. Relational database technology and more recently the advent of object-oriented databases and data warehousing are influencing how data is stored, updated and retrieved. Drawing from artificial intelligence advances, there is the potential for representing and using models in new and different ways. Clearly these emerging technologies will continue to expand the component parts of a DSS domain.

An area of rapid growth and enormous development potential is web-based DSS. DSS implemented on a corporate Intranet or the Internet with HyperText Markup Language (HTML) front-ends provide a simple means of integrating hypermedia into DSS (Bieber, 1995). It also

- DSS products have begun to incorporate (and will eventually encompass) tools and techniques from artificial intelligence. DSS will provide the mechanism for the assimilation of expert systems, knowledge representation, natural language query and voice and pattern recognition. The emerging result is described by Sprague and Watson (1996) as "intelligent DSS" that can "suggest", "learn" and "understand" in dealing with managerial tasks and problems;
- DSS groups have become less like special project "commando teams" and more an integral part of the support team for a variety of other end-user support; and
- cutting across all the above stated trends, is the continued development of user-friendly capabilities. Sprague and Watson (1996) maintain that this, more than any other feature, is what enabled early DSS. The development of dialog support hardware (*e.g.* light pens, mouse devices, touch screens and high-resolution graphics) will be further advanced by speech recognition, handwriting recognition and voice synthesis. Dialog support software (*e.g.* menus, Windows and Help functions) is continuing to advance. See, for example, Schiphorst (1996) for a discussion of using decision technologies operated via the World Wide Web.

Daily, incalculable amounts of information are generated, disseminated and stored away in organisations. Yet with technological advances and expenditures made with the goal of improving accessibility to information, very little (less than 5 percent) of an organisation's information base is actually computerised (Wallace, 1990). Furthermore, even a smaller percentage of this information is accessible online for managers and decision makers.

The information needs of senior level managers (and executives in particular) do not conform to the traditional concept of database querying. Fedorowicz (1989) reports that much of senior managers' information gathering is from various formal and informal sources. The researcher indicates that this information may come from internal memos, written reports, correspondence from customers, electronic mail messages, news items, conversations on a golf course or video clips. Some of the data is so informal that it may never be captured, stored and be made available through a DSS. Furthermore most of them have been excluded from traditional DSS because it has been technologically difficult or impossible to include them. Nowadays, there are technological the spatial features which allows for the analysis of spatially defined statistical data. De Savigny *et al* (1996) lists examples which include the investigation of issues pertaining to location, condition, trends, routing and patterns and the ability to model. Hall (1996) cites a number of instances in which GIS-based DSS have been used to great effect in developing countries for a number of different purposes.

## 2.9 Important Developments in DSS

The intersection of the continued progress in DSS and the trends cited in section 2.8, have resulted in some important developments in DSS. Sprague and Watson (1996) have identified the following trends:

- personal computer-based DSS continue to grow. Spreadsheets have taken on more and more functions and these have eventually encompassed some of the functions previously performed by DSS generators. Newer packages for "creativity support" have become popular as extensions of analysis and decision-making. These developments have strengthened the use of the PC for these applications. This is evident for personal support for independent thinking and decision-making rather than for institutional DSS such as budgeting and financial planning;
- for the popular institutional DSS that support sequential, interdependent decision making, there is a trend toward "distributed DSS" - close linkages between mainframe DSS languages and generators and the PC-based facilities. Nowadays vendors of both mainframe and PC products are offering versions that run on and link with the other;
- for interdependent decision support, GDSS has become more prevalent in the past few years. For a discussion on a multidimensional framework for GDSS research and design, see Venkatraman (1996). The growing availability of LANs, group communication services (*e.g.* electronic mail) and Internet technology (*e.g.* Oracle Corporation's product Oracle Web Agent® allows users to access Oracle Express Server® across the Internet and World Wide Web), will make this type of DSS increasingly available;

appropriate tools for both accessing the databases and performing the analysis and presentation. One such approach is the use of data warehouses; and

- **Data Warehousing**. Nowadays separate databases for decision support applications are being developed through the creation of data warehouses. These are special databases which are designed to allow decision makers to make their own analyses and are sometimes referred to as information databases. For an in depth discussion of data warehousing, see for example, Rob and Coronel (1997). Two examples of commercially available data warehousing tools are Oracle RDB® and Red Brick®. With a typical data warehouse, the needed data is first extracted from the mainframe and other databases. Prior to it being placed in the data warehouse, the data is processed (*i.e.* "cleaned") for making it more usable for decision support. Several vendors provide software specifically for this purpose (*e.g.* Prism®). The data is then maintained on a file server and special-purpose software is often used to support DSS activities better (*e.g.* Lightship® provides fast response times or complex queries against large files);

- the rapid increase in end-user computing and the increasing knowledge, expertise and computer literacy of end users;
- the growth of artificial intelligence (AI) techniques (*e.g.* ES) and natural language processing;
- the increasing availability of large colour screens and colour graphic software; and
- the increasing availability of mobile computing and communication.

Hall (1996) identifies Geographic Information Systems (GIS) as "an important recent approach to support decisions in development", since they are capable of "integrating geographical data [such as maps] with other data from various sources [such as databases] to provide the information necessary for effective decision making in planning sustainable development". The strength of GIS lies in the close integration of the spatial data (digital co-ordinates which are either points, lines or polygons) with the attribute database, containing characteristics and qualities of

Each of these trends had a significant effect on the growth and development of DSS. Taken together, their synergy has proved to be dramatic. They include:

- the personal computer revolution: the hardware, software and the emphasis on the ease-of-use through common interfaces (*e.g.* Windows) and common representations (*e.g.* spreadsheets);
- the increasing capability and decreasing cost of telecommunications, both for local area networks (LAN) and wide area networks (WAN) including the World Wide Web;
- the increasing availability of public databases and other sources of external data especially via online analytical processing (OLAP) and data warehousing technology:

    - **OLAP**. Managers and professionals doing decision support analyses without help from intermediaries or IS professionals is commonly referred to as OLAP. OLAP is driven by the need for information; the emergence of software that supports the building, maintenance and use of data warehouses; and more computer proficient end users who are competent and willing to do their own decision support (see Sprague and Watson, 1996; Gray and Watson, 1996; Parsaye, 1996; and Saylor, 1996). For example, Aborsoft's Essbase® and Essbase Web Gateway® allows developers to deliver OLAP applications directly from operational systems or within an overall data warehousing structure on the World Wide Web (see Arborsoft's Beverage Company demonstration of OLAP on a company Intranet at URL http://webgate.arborsoft.com/). For a list of examples of some commercially available OLAP tools, see Appendix A.

      OLAP involves many data items (frequently many thousands or even millions) in complex relationships (Turban *et al*, 1999). One objective of OLAP is to analyse these relationships and look for conditions of patterns, trends and exceptions. To execute OLAP, the manager needs the extract useful information that was previously buried in large quantities of data. Often data from various TPS are collected in data warehouses for this purpose. OLAP and data mining can then be used to analyse the data.

These two models will be further discussed in section 4.5.1.

Although the connotation of the DSS label might tend to be narrowing, the purpose and value of systems that fit the original definition of DSS continue to grow in importance. Sprague and Watson (1996) indicate that one reason for this apparent inconsistency is that it is increasingly difficult to identify the decision-making stages in the context all the other activities executives and managers must perform in dealing with ill-structured problems. Likewise, decision support technology has now broadened to include monitoring, tracking and communication tools to support the overall process of ill-structured problem solving.

DSS are studied in their use as supporting tools for planning, problem solving and decision-making in real-life, business context and as research instruments for developing conceptual frameworks and methodologies for management research. See, for example, Carlsson (1997).

## 2.11 Summary

In this chapter the three categories of decision-making were discussed. Decision-making processes consisting of the three processes of intelligence, design and choice were reviewed. The difference between structured and unstructured problems and their relationship to DSS was given.

The development of the DSS field was noted. A look was taken at DSS in the past and present and a working DSS definition given. The academic development of the field of DSS was discussed. The current important development and trends in DSS were reviewed. Finally, an overview of the current status of DSS was given.

# Chapter 3

## DSS AND OTHER RELATED TECHNOLOGIES

### 3.1 Introduction

Computers have been used as tools to support managerial decision-making for well over thirty years (Turban *et al*, 1999). Figure 3.1 represents a summary of the development of computerised procedures used as aids in decision-making.

**Figure 3.1 Aids in Decision-Making**

| Phase | Description | Example of Tools |
|---|---|---|
| Early | Compute "number crunch", summarise, organise | Calculators, early computer programs, statistical models, simple management science models |
| Intermediate | Find, organise and display decision-relevant information | Data base management systems, MIS, filing systems. Management science models |
| Current | Perform decision-relevant computations on decision-relevant information; organise and display the results. Query-based and user-friendly approach. "What if" analysis | Financial models, spreadsheets, trend exploration, operations research models, CAD systems, decision support systems |
| | Interact with decision makers to facilitate formulation and execution of the intellectual steps in the process of decision-making | Expert systems; executive information systems |
| Just beginning | Complex and fuzzy decisions situations, expanding to collaborative decision-making and to machine learning | Second generation of expert systems, group DSS, neural computing |

(Source: Adapted from Turban, 1995)

From Figure 3.1, the computerised tools or decision aids displayed may be grouped into seven categories:

- **Transaction Processing Systems (TPS)**. A TPS processes one transaction at a time and records the result of that activity;
- **Management Information Systems (MIS)**. These are computerised systems which analyse past transactions;

- **Office Automation Systems (OAS)**. These are systems that process office transactions (*e.g.* image and voice processing, teleconferencing, video conferencing, facsimile) and support office activities at all levels of the organisation;
- **Decision Support Systems (DSS) and Group DSS (GDSS)**. A DSS does not deal with transactions (Erwin and Blewett, 1998) and is capable only of supporting decision-making processes (Ahituv and Neumann, 1990). It uses uncertain formulas and estimates to predict the future. GDSS are discussed in section 4.5.5;
- **Expert Systems (ES)**. Expert systems are a branch of applied artificial intelligence (AI). AI will be discussed in section 3.6. Typically, an ES is a decision-making and/or problem-solving package of computer hardware and software that can reach a level of performance comparable to (or even exceeding that of) a human expert in some specialised and usually narrow problem area (Turban, 1995);
- **Executive Information Systems (EIS)**. These are computer-based systems which serve the information needs of top executives; and
- **Artificial Neural Networks (ANN)**. The application of all the previous six technologies is based on the use of *explicit* data, information or knowledge which is stored in a computer and manipulated as needed. In the complex real world, explicit data, information or knowledge may not be available. People must make decisions that are based on partial, incomplete or inexact information. For example, such conditions are created in rapidly changing environments. Decision makers are using their experiences to handle these situations whereby they are recalling experiences and *learning* from their experiences what to do with new similar situations for which *exact* replicas are not available. In all the previously stated technologies, there is no element of learning by the computer and a technology that attempts to close this gap is called neural computing or ANN. Much research and development is still needed. See, for example, Zeidenberg (1990).

Turban (1995) reports that there are several opinions about the evolution of MSS and their relationship to the other systems. He contends that a common view is that the recommendations and advice provided by MSS to the manager can be considered as information needed for final decisions made by humans. If this rationale and approach is accepted, then MSS can be considered as "sophisticated, high-level types of information systems" that can be used in addition to traditional TPS, OAS and MIS.

The evolutionary view of IS has a strong logical basis. Firstly, there is a clear-cut sequence through time: EDP systems appeared in the mid-1950s, MIS followed in the 1960s, OAS was developed mainly in the 1970s and DSS is a product of the 1970s which has expanded in the 1980s. Commercial applications of ES and EIS emerged in the 1980s. In the 1990s there has been an emergence of group support systems and neural computing as well as many integrated computer systems. Secondly, there is a common technology which links the various types of IS: the computer. It has evolved considerably over time. Thirdly, Turban (1995) indicates that there are "systemic linkages" in the manner in which each system processes data into information. An evolutionary view hereof in presented in Figure 3.2.

Figure 3.2 lists the attributes of TPS, MIS, DSS and ES classified into several dimensions. Only the most sophisticated attributes of each level are listed. Several lesser attributes can be found (although not listed) in most IS. The relationship among TPS, MIS, DSS, EIS and ES and other related technologies which are not shown in Figure 3.2 can be summarised as follows:

- the technologies can be seen as being unique classes of information technology;
- they are interrelated and each support some aspects of managerial decision making;
- the evolution and creation of the newer tools help expand the role of IT for the betterment of management in organisations; and
- the interrelationship and co-ordination between these tools continues to evolve.

It should be noted that the classification of IS does not imply that real-world computer systems must rigidly belong to only one category. A MIS may be coupled with a TPS or a DSS may be combined with a MIS and be integrated with an EIS (Turban, 1995).

The interactions among IS occur along two dimensions: applications (personnel management, scheduling, inventory control) and technology (hardware, software, processes). As McLean and Riesing (1977) observe, a DSS unlike a TPS, is basically discretionary in character. It has no justification or right to exist beyond the user's ability and desire to use it (Ahituv and Neumann, 1990).

**Figure 3.2 Attributes of the Major Computerised Support Systems**

| Dimension | Transactions Processing Systems (TPS) | Management Information Systems (MIS) | Decision Support Systems (DSS) | Expert Systems (ES) | Executive Information Systems (EIS) |
|---|---|---|---|---|---|
| Applications | Payroll, inventory, record keeping, production and sales information | Production control, sales forecasting, monitoring | Long-range strategic planning, complex integrated problem areas | Diagnosis, strategic planning, internal control planning, strategies | Support to top management decision, environmental scanning |
| Focus | Data transactions | Information | Decisions, flexibility, user friendliness | Inferencing, transfer of expertise | Tracking, control, "drill down" |
| Database | Unique to each application, batch update | Interactive access by programmers | Database management systems, interactive access, factual knowledge | Procedural and factual knowledge; knowledge base (facts and rules) | External (online) and corporate, enterprise wide access (to all databases) |
| Decision capabilities | No decisions | Structured routine problems using conventional management science tools | Semi-structured problems, integrated management science models, blend of judgment and modelling | The system makes complex decisions, unstructured; use of rules (heuristics) | Only when combined with a DSS |
| Manipulation | Numerical | Numerical | Numerical | Symbolic | Mainly numeric; some symbolic |
| Type of information | Summary reports, operational | Scheduled and demand reports, structured flow, exception reporting | Information to support specific decisions | Advice and explanations | Status access, exception reporting, key indicators |
| Highest organisational level served | Sub-managerial, low management | Middle management | Analysts and managers | Managers and specialists | Only senior executives |
| Impetus | Expediency | Efficiency | Effectiveness | Effectiveness and expediency | Timeliness |

(Source: Adapted from Turban, 1995)

Since the establishment of computers as business tools, designers have planned for the day when systems can work on their own either as decision makers or as partners in the decision making context (Sauter, 1997). Computers such as these would use AI. This is the emulation of human expertise by the computer through the encapsulation of knowledge in a particular domain and procedures for acting on that knowledge. The application of AI in a DSS is briefly discussed in section 3.6.

As DSS is juxtaposed between two distinct neighbours (see Figure 3.2), the MIS-DSS connection is discussed in section 3.2. For the right side neighbour, the DSS-ES connection is discussed in section 3.3. Distinguishing DSS characteristics and capabilities which provide some major benefits, will be summarised. Section 3.5 then discusses the integration of EIS, DSS and ES.

## 3.2 A MIS-DSS Neighbourly Connection?

Turban (1995) states that what can be expected from a DSS is less typically possible with an MIS. This does not mean than a MIS cannot have these features. It rather implies that they are not common to most MIS. A DSS can specifically be used to address *ad hoc* unexpected problems. Most MIS decision support is supplied by structured information flows in the form of exception and summary reports. An exception report highlights items that require special attention. Accordingly structured reports are of limited value for unique problems in that either the needed information is not provided for or it is in the incorrect format.

On the contrary, a DSS can provide a valid representation of a complex real-world system. Furthermore, a DSS can supply decision support within a short frame of time. In a MIS, if the model is not already available, the lead time for writing programs and getting answers is often too long to help many decision situations.

A DSS can evolve as the decision maker learns more about the problem. In many cases, managers cannot specify upfront what they require from computer programmers and model builders. Consequently many computerised applications are developed in a way that requires detailed specifications to be formalised in advance. Unfortunately in many semi-structured and unstructured decision-making tasks, this requirement is not reasonable.

A DSS is often developed by non data processing (DP) professionals. This is possible because of many software packages that are available. See Appendix B. However, in the case of most MIS applications and systems, these are developed by DP professionals.

These distinguishing DSS features are now summarised. A DSS can:

- be used to address *ad hoc*, unexpected problems;
- provide valid representation of the real-world system;
- provide decision support within a short time frame;
- evolve as the decision maker learns more about the problem; and
- be developed by non data processing professionals.

Keen and Scott Morton (1978) have noted the distinctive nature of DSS and Figure 3.3 summarises the differences they see between MIS, operations research/management science (OR/MS) and DSS.

**Figure 3.3 The Characteristics of MIS, OR/MIS and DSS**

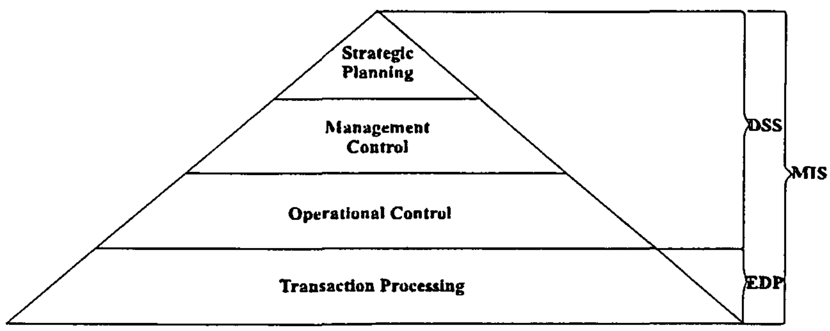
| |
|---|
| **Management Information Systems** |
| The main impact has been on structured tasks, where standard operating procedures, decision rules and information flows are reliably predefined |
| The main pay off has been in improving efficiency by reducing costs, turnaround time and by replacing clerical personnel |
| The relevance for managers' decision-making has mainly been indirect, *e.g.* by providing reports and access to data |
| **Operations Research/Management Science** |
| The impact has most been on structured problems (rather than tasks) where the objective, data and constraints can be prespecified |
| The payoff has been in generating better solutions for given types of problems |
| The relevance for managers has been the provision of detailed recommendations and new methodologies for handling complex problems |
| **Decision Support Systems** |
| The impact is on decisions in which there is sufficient structure for computer and analytical aids to be of value but where the managers' judgment is essential |
| The payoff is in extending the range and capability of computerised managers' decision processes to help them improve their effectiveness |
| The relevance for managers is the creation of a supportive tool (under their own control) that does not attempt to automate the decision process, predefine objectives or impose solutions |

(Source: Adapted from Keen and Scott Morton, 1978)

Another way in which to look at the relationships between DSS and MIS is provided by McLean (1982). He uses Anthony's framework where the three levels of organisational activities are shown as a triangle. There is an added level for transaction processing. Transaction processing is primarily done at the operational level.

In theory, MIS was to serve all levels of managerial activities. Consequently DSS may be considered a subset of MIS. See Figure 3.4.

**Figure 3.4 Relationship between EDP, MIS and DSS**




(Source: McLean, 1982).

However, in practice, MIS has fallen short of this objective and proponents of DSS argued that their approaches were better suited to the upper two layers of decision making. Similar to McLean's stance is the notion that MIS is an umbrella that supports all managerial activities. In this scenario DSS is viewed as the portion that deals with unstructured situations while management science deals with structured problems.

## 3.3 A DSS-ES Neighbourly Connection?

Turban (1995) states that DSS and ES seem to be completely different and unrelated computerised systems. Turban and Watkins (1986) discuss the differences between DSS and ES along eleven attributes.

As can be seen from Figure 3.5, there are significant philosophical, managerial and technological differences between these two tools. These differences are not discussed here nor is the integration of the tools examined. Several researchers and practitioners have proposed models for integrating DSS and ES. See, for example, Van Weelderen and Sol (1993). Such an integration appears under several names ranging from **intelligent DSS** to **expert support systems.**

The disciplines of DSS and ES grew up along parallel but largely independent paths. Only recently has the potential of integrating the two disciplines been recognised. Turban (1995) states that because of the different capabilities of the two tools, they are able to complement each other thereby creating a powerful, integrated, computer-based system that can considerably improve managerial decision-making.

**Figure 3.5 Differences between DSS and ES**

| | DSS | ES |
|---|---|---|
| Objective | Assist human decision maker | Replicate (mimic) human advisers and replace them |
| Who makes the recommendations (decisions)? | The human and/or the system | The system |
| Major orientation | Decision-making | Transfer of expertise (human-machine-human) and rendering of advice |
| Major query direction | Human queries the machine | Machine queries the human |
| Nature of support | Personal, groups and institutional | Mainly personal and some groups |
| Manipulation method | Numerical | Symbolic |
| Characteristics of problem area | Complex, integrated wide | Narrow, specific domain |
| Types of problems | *Ad hoc*, unique | Repetitive |
| Content of database | Factual knowledge | Procedural and factual knowledge |
| Reasoning capability | No | Yes, limited though |
| Explanation capability | Limited | Yes |

(Source: Adapted from Turban, 1995)

## 3.4 Distinguishing Characteristics and Capabilities of DSS

Leigh (1983) indicates that the attraction of DSS is that they are an extension of the manager's mind in exploring the probable consequences of alternative decisions. However, as shown in section 2.6, there is no consensus on what a DSS is. Clearly, there will be no agreement on the characteristics and capabilities of DSS. However, Turban (1995) formulates a list as an ideal set.

He indicates that most DSS have only *some* of the listed features:

- DSS provides support for decision makers primarily in semi-structured and unstructured situations by bringing together human judgment and computerised information. Such problems cannot be solved easily or conveniently by other computerised systems (*e.g.* EDP or MIS) nor by standard quantitative tools or methods;
- support is provided for various managerial levels which ranges from top executives to line managers;
- support is provided to groups as well as individuals. Many organisational problems involve group decision-making. The less structured problems often require the involvement of several individuals from different organisational levels and departments;
- DSS provides support to several interdependent and/or sequential decisions (see section 2.2);
- DSS supports all phases of the decision-making process: intelligence, design choice (see section 2.2) and implementation (this phase added by Turban, 1995);
- DSS supports a variety of decision-making styles and processes. There is a fit between the DSS and the attributes of the individual decision makers (*e.g.* decision style and the vocabulary);
- DSS is adaptive over the passage of time. The decision maker should be quickly reactive to changing conditions and adapt the DSS to meet these changes. As DSS are flexible, users can add, combine, delete, change or rearrange basic elements thereby providing fast response to unexpected situations. This facilitates timely and quick *ad hoc* analyses;
- DSS is easy to use and users must feel intuitively "comfortable" with the system. User-friendliness, strong graphic capabilities, flexibility and an English-like human-machine interface language can greatly increase the effectiveness of DSS. This ease of use implies a dynamic interactive mode;
- DSS attempts to improve the effectiveness of decision-making (quality, accuracy, timeliness) rather than efficiency (cost of making the decision, including computer time charges). Bennett (1983) suggests that DSS development projects are

undertaken primarily because decision makers see value in having some problem solved. The solution is perceived to be valuable in that it may enhance the *effectiveness* of the decision maker, not because it will improve efficiency;

- the decision maker has complete control over all steps of the decision-making process in solving a problem as a DSS specifically aims to support and *not* replace the decision maker. At any time, the decision maker can override the computer's recommendation(s);
- DSS leads to learning and which leads to new demands and a refinement of the system. This in turn leads to additional learning and this continuous process leads to a developing and improving of the DSS;
- end-users are able to construct simple systems on their own. Larger systems can be built in users' organisations with relatively minor assistance from IS specialists;
- a DSS usually utilises models (custom-made or standard) for analysing decision situations. The modelling capability enables experimenting with differing strategies under different configurations and such experimentations can provide new learning and insights; and
- advanced DSS are equipped with a knowledge component that enables the effective and efficient solution of very difficult problems.

These distinguishing capabilities and characteristics provide some major benefits:

- the ability to support the solution of complex problems;
- a fast response to unexpected situations that result in changed conditions. A DSS enables a thorough quantitative analysis in very short time and even frequent changes in complex scenarios can be evaluated objectively in a timely manner;
- the ability to try several different strategies under different configurations, quickly and objectively;
- new insights and learning whereby the user can be exposed to new insights through the composition of the model and an extensive "what if" analysis. New insights may assist in training inexperienced managers and other employees;
- communication is facilitated among managers in that data collection and model construction experimentations are executed with active users' participation. These

decision processes may make employees more supportive of organisational decisions. By using "what if" analyses, sceptics may be satisfied and thereby foster teamwork;

- DSS can increase management control over expenditures and also improve performance of the organisation;
- routine applications of a DSS may result in considerable cost savings or reducing (or eliminating) the cost of incorrect decisions;
- the decisions derived from DSS are more objective and consistent than those made intuitively;
- DSS promotes improved managerial effectiveness allowing managers to perform a task in less time and/or with less effort. This in turn provides managers with more "quality" time for analysis, planning and implementation; and
- improved productivity of users and analysts.

DSS are fundamentally concerned with improving the effectiveness and efficiency of knowledge management activities that occur in the course of decision-making (Holsapple and Whinston, 1996). Walden (1996) states that "DSS lead to more satisfactory decision-making processes".

## 3.5 Integrating EIS, DSS and ES

An ES can be integrated with a DSS as it is especially common for EIS to be used as a source of data for PC-based modelling products (Turban, 1995). The researcher cites the following example: at a large pharmaceutical company, brand managers download the previous day's orders of their products from Pilot's Command Centre® (an EIS) and this download creates a Lotus-readable file on their PC disk. The managers then exit to the PC and run a Lotus® DSS model against the data to predict where they will be at the end of the month. The results of this model are subsequently uploaded to the EIS. So, by 11h00 senior managers access their EIS and see, for example, each brand manager's projected month end sales target.

The integration of EIS and DSS can be accomplished in several ways. It is likely that the information generated by the EIS is used as an input to the DSS but more sophisticated systems include feedback to the EIS (Turban, 1995). They may even have an explanation capability and include an ES that makes the system intelligent.

The World Wide Web is a perfect medium for deploying DSS and EIS capabilities on a global basis (Turban *et al*, 1999). Some of these capabilities are:

- the DSS/EIS builder can access the World Wide Web pages and data of organisations that are related to the DSS project, thus saving time;
- the World Wide Web supports interactive DSS-related queries and *ad hoc* report generation. The users can select a list of variables from a pull down menu when expecting a predefined query or report. This gives the builder the ability to customise the DSS/EIS output; and
- web-based application servers download Java aplets that execute functions on desktop DSS/EIS programs. This gives users the capabilities of advanced DSS application without requiring client software to be loaded. Users only require a Web browser.

Most vendors of decision support applications have modified their tools in order for them to work across the World Wide Web (Turban *et al*, 1999).

Building an integrated, intelligent IS can be greatly facilitated by the use of integrated development tools. These are tools that provide easy interfaces to other tools (*e.g.* spreadsheets, databases and graphics). Many ES development tools offer interfaces to spreadsheets, databases, graphics, hypertext technology and word processing; and some of them have a natural language interface. Many factors should be considered when systems are integrated but these are not discussed here.

## 3.6 AI and DSS

The advantage of AI is that computers are not prone to the forgetfulness, bias or distraction that plague human decision makers (Sauter, 1997). AI has two roles in a DSS:

- AI can serve as a model type. In particular, it is an heuristic modelling technique which manipulates symbols rather than numbers. This kind of modelling replicates the human reasoning process making it most useful when addressing poorly structured problems or problems for which data is not complete; and
- AI provides intelligent assistance to the users. With the use of AI, designers are able to build into the DSS expertise in modelling, evaluation of alternatives or in post-modelling analysis to improve the quality of decision for all users.

Sauter (1997) states that over time almost all DSS will include some kind of AI. The researcher indicates that at present AI tends to be associated with choices needing some expertise where the expert is not always available or is expensive, where decisions are made quickly and where there are too many possibilities for an individual to consider at one time and there is a high penalty associated with missing one or more factors.

## 3.7 Summary

In this chapter the evolution of computerised decision aids and the grouping into seven categories was given. The attributes of each of the major computerised systems was then discussed. The connection between the two DSS "neighbours" was noted and the distinguishing features of MIS, DSS and ES were summarised.

The integration of EIS and DSS, and the application of AI in DSS were then discussed.

In section 2.6 an attempt was made to answer the question "What is a DSS?" by suggesting a working definition of a DSS. Whilst the characteristics and capabilities of DSS were identified and the role of AI indicated in Chapter 3, the components of DSS need to be discussed. These will be dealt in the next chapter. It should be noted, however, that this research will not focus on the technical aspects of DSS (including hardware and software). Only an overview of these components will be given.

# Chapter 4

## A FRAMEWORK FOR DSS ARCHITECTURE

### 4.1 Introduction

As was seen in Chapter 2, there are many definitions of DSS. At the minimum, DSS is designed to support complex managerial problems that other computerised techniques cannot. DSS is a computer-based system that supports choice by assisting the decision maker in organising information and modelling outcomes (Sauter, 1997).

The characteristics and capabilities of DSS have been identified and the major benefits highlighted. Now the *components* of DSS need to be discussed. The major components of a DSS are: database and its management, model base and its management and a friendly user interface (Sauter, 1997). An intelligent (knowledge) component can be added.

### 4.2 Components of DSS

According to Turban (1995), DSS is composed of the following subsystems:

#### 4.2.1 Data Management

The data management includes the database(s) which contains the relevant data for the particular situation and is managed by software known as database management systems (DBMS). The DBMS is composed of the following elements:

- **DSS database.** A database is a collection of interrelated data organised so that it corresponds to the needs and structures of an organisation and can be used by more than one person for more than one application. The data in the DSS database may include internal data sources, external data, private (personal) data belonging to one or more users or public data. For example, in the case of public data, DSS designers need to ensure that access can be provided not only the interface to access the database but also a link to the Internet through a network or modem connection (Sauter, 1997). For a discussion of database systems, see for example, Connolly and Begg (1999).

In order to create a DSS database it is very often necessary to capture data from various sources. This operation is known as extraction. In essence it is the importing of files, summarisation, filtration and the condensation of data. Extraction also occurs when the user generates reports from the data in the DSS database. The extraction process is managed by a DBMS;

- **Database Management System**. DBMS are fairly complex and have varied capabilities so that only a few users can program and develop their own DBMS software. The trend has been for the purchase of standard software packages. Examples of micro DBMS are dBASE IV® and ORACLE® and for mainframes, CA-DATACOM/DB® and DB2®. A DBMS can be part of the DSS generator or a package of its own that interfaces with the DSS. For example, Lotus 1-2-3® includes a DBMS or it can be used together with dBASE IV®. A DBMS performs three basic functions: it enables the storage of data in the database, retrieval of data from the database and control of the database;
- **Data Directory**. The data directory is a catalogue of all the data in the database and it contains the data definitions. Its main function is to answer questions about the availability of data items, their source or their precise meaning. The directory is especially appropriate for supporting the intelligence phase of the

decision-making process by helping to scan data and identify problem areas or opportunities. As does any other catalogue, the directory supports the addition of new entries, deletion of entries and retrieval of information on specific objects; and

- **Query facility**. This was achieved by the creation of query languages and the accompanying software to process requests stated in such languages (Bonczek *et al*, 1981; and Sprague and Carlson, 1982). Three important features of these languages are that queries:

    - have an English-like appearance;
    - are non procedural; and
    - can be submitted in an *ad hoc* manner.

For a summary of a time-based comparison and contrast of the evolution of DBMS, see Figure 4.1. This figure has been adapted from the slide show entitled "The Changing Technological Context of Decision Support Systems" at the recently held IFIP WG 8.3 presentation at "Context-Sensitive Decision Support Systems" Conference, Bled, Slovenia during 23-25 July 1998 (Power and Kaparthi, 1998).

**Figure 4.1 A Comparison and Contrast of the Evolution of DBMS**

| Database Management System | |
|---|---|
| **1982** | **1998** |
| Flat File Model Commonly Used | Powerful relational DBMS |
| Limited Use of relational DBMS | Use of Multi-Dimensional Databases |
| Focused on Numerical and Text Data | World Wide Web Access to Databases |
| Size in Megabytes | Multimedia Databases |
| | Size in Giga and Terabytes |

(Source: Adapted from Power and Kaparthi, 1998)

### 4.2.2 Model Management

The model management subsystem of a DSS is composed of the following elements:

- **Model Base**. A model base contains routines and special statistical, management science, financial and other quantitative models that provide the analysis capabilities in a DSS. The ability of invoke, change, run, combine and inspect models is a key capability in DSS that differentiates it from the traditional IS. The models in the model base can be divided into four primary categories: strategic, tactical, operational, and model building blocks and subroutines (the details of which are based on Kroeber and Watson, 1986). For the purposes of this research these are not pursued any further. The models in the model base can also be classified by functional areas (*e.g.* production and control models, financial models) or by discipline (*e.g.* statistical models, management science allocation models). The number of models in a DSS can vary from a few to many hundreds. For example, Oliff (1984) cites a DSS for a large transportation organisation which includes over 175 models;
- **Model Base Management System (MBMS)**. The MBMS is a software system that has the following functions: model creation, using subroutines and other building blocks; generation of new reports and routines; model updating and changing; and data manipulation;
- **Modelling Language**. Even though some of the models in the model base are prewritten, it is often necessary to write a model (Turban, 1995). This can be undertaken with a high-level language (*e.g.* COBOL) or better with fourth-generation languages (4GL) and special modelling languages;

- **Model Directory**. The role of the model directory is similar to a database directory in that it is a catalogue of all the models in the model base. It contains the model definitions. Its main function is to answer questions about the availability and capability of the models. An issue in a DSS may be "which models should be used for what occasion?". Such model selection cannot be done by the MBMS as it requires expertise. It is a potential area for a knowledge component "assisting" the MBMS; and
- **Model execution, Integration and Command**. These activities are usually controlled by model management and embrace the control of the actual running of the model, combining the operations of several models when needed (*e.g.* directing the output of one model to be processed by another one). A modelling command processor is used to accept and interpret modelling instructions as the flow from the dialog component and route them to the MBMS, the model execution or to the integration functions. The execution of computations with the models requires the retrieval of data items from the DSS's databases or from other databases and this activity is performed through a database interface.

4.2.3 Communication (dialog subsystem)

The dialog component of a DSS is the hardware and software that provides the *user interface* for DSS. The user is in direct communication with the computer system and can affect its activities (Capron, 1997). The term *user interface* covers all aspects of the communications between a user and a DSS (Turban, 1995). It includes not only the software and hardware but also the factors that deal with ease of use, accessibility and human-machine interactions. Some DSS experts are of the opinion that user interface is the most important component because much of the power, flexibility and ease-of-use characteristics of DSS are derived from this component. See Sprague and Carlson (1982). Sauter (1997) states "the user interface is the most important part of a DSS". An inconvenient user interface is one of the major reasons why some managers have not used computers and quantitative analyses to the extent that these technologies have been available. Sauter (1997) suggests that many users think of the user interface as the *real* DSS as it is the part of the system they see.

### 4.2.4 Knowledge Management

This is an optional subsystem which can support any of the other subsystems or act as an independent component. Many unstructured and semi-structured problems are so complex that in addition to the regular capabilities, they require expertise for their solution. Such expertise can be provided by an ES. Therefore the more advanced DSS are equipped with a component called knowledge management (Turban, 1995). Such a component can provide the required expertise for solving some aspects of the problem and/or providing knowledge that can further enhance the operation of the other DSS components. The knowledge management component is composed of one or more expert systems and like data and model management, knowledge management software provides the necessary execution and integration of the expert system. A DSS that includes such a component is referred to as an intelligent DSS, a DSS-ES or a knowledge-based DSS. An example is in the area of estimation and pricing. See, for example, Kingsman and de Souze (1997).

The user is also considered to be a part of the system. Some of the unique contributions to DSS are derived from the interaction between the computer and the decision maker (Turban, 1995).

## 4.3 The User

The person faced with the problem or decision that the DSS is designed to support has been referred to as the *user*, the *manager* or the *decision maker* (Kroeber and Watson, 1986). However, these terms fail to reflect the heterogeneity that exists among users and the usage patterns (*e.g. terminal mode* where the decision maker is the direct user of the system through online access) of DSS. There are differences in the positions that users hold in an organisation, the way in which a final decision is reached, the users' cognitive preferences and abilities, and the ways of arriving at a decision (decision styles). For example, Elam (1992) summarises the existing behavioural research and provides many suggestions for behavioural decision theory and DSS. Konsynski and Stohr (1992) suggest broadening the decision-making topics for DSS research. However, none of these aspects is the focus of this work.

A DSS has two broad classes of users: managers and staff specialists (Turban, 1995). In this study the former class is focused on during the interview process. Staff specialists include production planners, financial analysts and marketing researchers. Knowing who will actually have hands-on use of the DSS is important during the design phase. Generally, managers expect systems to be more user-friendly than do staff specialists. Turban (1995) states that staff specialists tend to be more detail-oriented, are more willing to use complex systems in their day-to-day work and are very interested in the computational capabilities of the DSS. In many cases, it has been found that the staff analysts are the intermediaries between management and DSS.

Managers differ by organisational level, functional area, educational background and need for analytic support. None of these factors forms part of this research. For a methodology for overcoming organisational and behavioural implementation barriers see, for example, Dologite and Mockler (1989).

## 4.4 DSS Hardware and Software

DSS have evolved simultaneously with advances in computer hardware and software technologies (Turban, 1995). Hardware affects the usability and functionality of DSS. Even though the choice of hardware may be made before, during or after the design of the DSS software, in many instances the hardware choice is predetermined by what is already available within the organisation.

Some DSS hardware options are:

- **The organisation's Mainframe computer, a Minicomputer, a Personal Computer**. If the DSS is located in-house, a mainframe, workstation, mini- or personal computer may be used. A combination of these may be used for a distributed system. Turban (1995) indicates that there are a variety of factors which can influence the type of computer used, including what kind of computers are available inhouse, the type of decision support to be provided, the computational power that is required, the data needs of the DSS, the software demands of the DSS and the existing network system(s). A major reason for placing a DSS inhouse is that the required hardware and software may already be available but this need not be the limiting consideration. It is not uncommon for software (and sometimes hardware) to be purchased specifically for DSS. The range of DSS users also influences what hardware is to be used and the placement thereof. If, for example, the system is to support users through an organisation, an enterprise client/server architecture may be required. Conversely, if the DSS is to provide decision support for one person, a personal computer may be used. See Hackathorn and Keen (1981). Current developments in the area of client/server architecture, parallel processing and networks of computers can have a major impact on hardware selection.

  The data needs of the DSS may also play a role in determining the hardware selection. As some DSS require considerable data from the organisation's database, it may be advantageous to place the DSS on the same system where the database is maintained. However, Turban (1995) points out that this may not be as important a consideration as it might first seem as experience has shown that the data needs of many DSS differ considerably from what is maintained in existing databases. Hence it may be more practical to download and extract data from the organisation's corporate database to the DSS database or even directly to a personal computer.

Some DSS require significant computational power (*e.g.* for simulation models which require a large number of calculations) and which necessitates the use of large, fast machines. Multidimensional reports constructed from a large number of files also require significant memory and/or access to several databases.

As outlined in section 2.4, the DSS software is composed of the DBMS, MBMS and dialog management. There may also be additional software for added capabilities (*e.g.* multimedia, knowledge-base); or

- **a Distributed System**. An increased number of DSS are available on networks, either LANs and/or WANs including the World Wide Web. The advantages of such systems are the accessibility of the DSS to data and models in many locations and the availability of the DSS to users in many locations.

Computer hardware and software have made considerable progress in recent years aiming in providing background for the design of better DSS (Petkov and Mihova-Petkova, 1996).

## 4.5 Classifications of DSS and Their Support

There are several ways to classify DSS and some of these overlap (Turban, 1995). The design process, as well as the operation and *implementation* (own italics added) of DSS in many cases depends on the type of DSS involved. Representative classification schemes are presented next.

### 4.5.1 Types of Support: Data-oriented versus Model-oriented

The concept of data-oriented and model-oriented DSS was introduced in section 2.10. This classification by Alter (1980) is based on the "degree of action implication of system outputs"; *i.e.* the extent to which system outputs can directly support (or determine) the decision. According to this classification, there are seven categories of DSS. The first three types are *data-oriented* performing data retrieval and/or analysis and the remaining four are *model-oriented* providing either simulation capabilities, optimisation or computation that "suggest an answer". Not every DSS fits snugly into a single classification system as some have equally strong data and modelling orientation.

### 4.5.2 Institutional versus *ad hoc* DSS

This classification by Donovan and Madnick (1977) is based on the nature of the decision situation that the DSS are designed to support. The two categories are:

- **Institutional DSS**. This type of DSS deals with decisions which have a *recurring* nature. An institutional DSS may be developed and refined over a number of years because the DSS will be used over and over again (with appropriate updating of the models and databases) to solve similar or identical problems; and
- ***Ad hoc* DSS**. This type of DSS deals with specific problems which neither reoccur nor were anticipated. To economically justify such a situation, it is necessary to use general-purpose software for information retrieval, data analysis and modelling that can be rapidly and inexpensively customised for each specific application. The concept of DSS generators (which is discussed in the next section) was developed to provide a means for satisfying *ad hoc* needs for decision-making support.

The labels of "institutional" and "*ad hoc*", which are applied to DSS, can also relate to the number and types of users (Donovan and Madnick, 1977). The characteristics of each type of DSS are summarised in Figure 4.2.

These researchers suggest that the characteristics of institutional and *ad hoc* DSS lead to the conclusion that institutional DSS are most appropriate for operational control applications whilst *ad hoc* DSS are most useful for strategic planning applications. There is an overlap with regards to management control applications.

**Figure 4.2 Comparison of Institutional and *ad hoc* DSS**

| | **Institutional DSS** | ***Ad hoc* DSS** |
|---|---|---|
| Number of decision occurrences for a decision type | many | few |
| Number of decision types | few | many |
| Number of people making decisions of same type | many | few |
| Range of decision supported | narrow | wide |
| Range of users supported | narrow | wide |
| Range of issues addressed | narrow | wide |
| Specific data needed to know in advance | usually | rarely |
| Problems are recurring | usually | rarely |
| Importance of operational efficiency | high | low |
| Duration of specific type of problem being addressed | long | short |
| Need for rapid development | low | high |

(Source: Donovan and Madnick, 1977)

Until 1983, many of the DSS developed were institutional in nature due to the high cost of developing DSS for nonrecurring use. See Alter (1980) and Meador *et al* (1984a). However, with the increased availability of general purpose tools (coupled with their steady decreasing costs and increasing capabilities) and with the appearance of DSS for personal computers, it is possible nowadays to build *ad hoc* DSS in a relatively inexpensive manner. Perhaps the most significant advance for DSS was the invention of electronic spreadsheet software in the late 1970s (see, for example, Lucas, 1986a; and Parker, 1991).

### 4.5.3 Degree of Nonprocedurality

This classification by Bonczek *et al* (1980) is based on the degree of nonprocedurality of data retrieval and modelling languages provided by the DSS. Procedural languages (*e.g.* COBOL and BASIC) require step-by-step specifications of how data is to be retrieved and how computations are to be performed. In nonprocedural languages (also known as fourth-generation languages), the system itself is programmed so that programmers are required to specify only what results are needed. The sequence of execution need not be specified. Most DSS users find nonprocedural languages more convenient for both data retrieval and modelling activities (Turban, 1995).

### 4.5.4 Personal, Group and Organisational Support

According to Hackathorn and Keen (1981), the support given by DSS can be separated into three distinct but interrelated categories:

- **Personal support**. The focus is on an individual user (or group of users) performing an activity in a discrete decision or task (*e.g.* recommending a Johannesburg Stock Exchange share transaction). The task is independent of other tasks;
- **Group (team) support**. Here the focus is on a group of people, each of whom is engaged in separate but very interrelated tasks. An example is a corporate finance department where one DSS may serve several employees, all working on the budget; and
- **Organisational support**. The focus is on organisational tasks or activities involving a *sequence* of operations, different locations, different functional areas and massive resources. As an illustration, for example, a sequence of decisions may be composed of long-term planning, short-term planning, resource allocation and job assignment decisions.

### 4.5.5 Individual versus Group DSS

Many DSS are used to support an individual decision maker. Many researchers and practitioners (*e.g.* Keen, 1980) point out that the fundamental model of DSS as "the lonely decision maker striding down the hall at high noon to make a decision" is true for only minor decisions. In most organisations, most *major* decisions are made collectively. In making decisions collectively the group has to work together, communicate with each other and eventually arrive at a decision. This is a complicated process which can be supported by computers. This is basically what is known as a group DSS (GDSS).

Definitions of GDSS have been offered by Huber (1982) and DeSanctis and Gallupe (1985). Sprague and Watson (1996) report that these definitions serve their purposes well:

- "A GDSS consists of a set of software, hardware, and language components and procedures that support a group of people engaged in a decision-making meeting" (Huber, 1982); and
- "An interactive, computer-based system which facilitates the solution of unstructured problems by a set of decision makers working together as a group" (DeSanctis and Gallupe, 1985).

It is important to note that the group using the GDSS may not make the ultimate decision (Gray and Nunamaker, 1989).

DSS and ES technologies may be integrated. Consequently the role of ES in decisions made by groups (*e.g.* in GDSS) can be extremely important. For further discussion, see Agarwal and Prasad (1989). GDSS are, however, not included in this research.

### 4.5.6 Custom-made versus ready-made Systems

Many DSS are custom made for individual users and organisations as the problem is nonroutine and not structured. However, similar problems may exist in similar organisations (*e.g.* universities, hospitals, banks, *etc*). Likewise, certain nonroutine problems in a functional area (internal audit, accounting, finance) can repeat themselves in the same functional area of different organisations. It therefore makes sense to build generic DSS that can be used (sometimes with minor modifications) in several organisations of a similar nature. Such DSS are called *ready-made* and are sold by various vendors. Examples of *ready-made* systems are Hewlett Packard's Quality Decision Management® and Tymcom 370® (Equitable Life Insurance - Real Estate Application). Turban (1995) states that there has been an increased number of ready-made DSS due to their increased flexibility and reduced cost.

## 4.6 Technology Levels

A useful framework for understanding DSS construction issues was devised by Sprague and Carlson (1982). See previous discussion in section 2.4.2. The researchers identified three levels of DSS technology:

- **Specific DSS** (DSS applications). Turban (1995) indicates that the "final product" or the DSS application that actually accomplishes the work is called a specific DSS (SDSS);
- **DSS generators** (or engines). This is an integrated development software that accord to Sprague (1980) "provides a set of capabilities to build specific DSS easily, rapidly and inexpensively". For commercially available examples, see Appendix C. A generator can possess diverse capabilities ranging from modelling, report generation and graphical display to performing risk analysis. In the past these capabilities were available separately but nowadays they are integrated into an easy-to-use package.

  There has been an evolutionary growth from two directions toward what may be described as an "ideal" generator. One direction is *special-purposes languages* initially developed for mainframes. Examples of such languages are Interactive Financial Planning System (IFPS Plus®) and Oracle Express®. The other direction is micro-based *integrated software systems* like Quattro Pro® and Excel® which are constructed around spreadsheet technology; and
- **DSS tools**. At the lowest level of DSS technology are the software tools (or utilities) and these elements facilitate the *development* of either a DSS generator or a specific DSS. Turban (1995) cites examples of DSS tools such as graphics (hardware and software) editors, random number generators, query systems and spreadsheets.

The relationships among the three levels is as follows: the tools are used to construct generators, which in turn are used to construct specific DSS. Tools can also be used to construct specific DSS (see Figure 2.3). In addition there may be simpler tools for constructing more complicated tools.

## 4.7 The DSS Development Process

DSS development commences with a recognised decision support need or opportunity (Holsapple and Whinston, 1996). The construction of a DSS involves issues ranging from technical (*e.g.* hardware selection and networking) to behavioural (*e.g.* man-machine interfaces) and the potential impact of DSS on individuals and groups. This section concentrates primarily on construction issues involving software.

A survey of major DSS methodologies used for DSS development was conducted by Arinze (1991). This researcher analysed them by structure, paradigm and orientation and discusses their underlying assumptions. A contingency approach was developed that shows how each methodology reduces the lack of structure in the decision-making environment. For a comparative study of various DSS development methodologies, see Saxena (1992). As this research does not focus on DSS development (but rather on DSS *implementation*), these methodologies will not be presented here.

### 4.7.1 Development Strategies

Several basic development strategies for DSS exist and they are:

- Writing a customised DSS. This is achieved in a general-purpose programming language (*e.g.* COBOL or PASCAL). Whilst this strategy was viable during the 1970s, very few organisations use it in the 1990s. Where many interfaces with other IS are required (*e.g.* in very large-scale DSS) these are usually built from scratch;
- Using a fourth generation language. These tools (*e.g.* spreadsheets, data-oriented languages and financial-oriented languages) can boost programmers' productivity over general-purpose languages;
- Using a DSS generator. These packages eliminate the need to use multiple 4GLs by integrating several tools into one package (*e.g.* Lotus 1-2-3®, Quattro Pro® and Excel®);
- Using domain-specific DSS generator. Domain-specific DSS generators are designed to build a highly structured system for a

functional area. There are several packages for building strategic management systems. See, for example, Mockler (1992);

- Developing the DSS using CASE methodology; and
- Developing a complex DSS by integrating some of the above approaches. Such an approach is suitable for distributed DSS and for use in a Windows environment.

As shown, the development strategy is dependent on many factors. The DSS development process will now be discussed.

### 4.7.2 The DSS Development Process

As DSS addresses semi-structured or unstructured problems, managers' perceived needs for information will change and so must the DSS follow suit. Hence most DSS are developed by a prototyping process which is different from the traditional development life cycle process of information systems. The prototyping approach is known as the **evolutionary process** (Keen, 1980), **iterative process** (Sprague and Carlson, 1982) or simply **prototyping** (Henderson and Ingraham, 1982). None of these processes is discussed in any detail.

This subsection describes the development process and includes all the activities that can go into a complex DSS development. It may be considered as the classical DSS development (Turban, 1995). Nowadays there are many variations and supplements to the process. However, the major phases and activities remain valid in the various development methodologies. It should be noted that not all activities are performed for every DSS (*e.g.* a simple *ad hoc* DSS may undergo a shorter process, and a user-developed DSS may involve both a shorter process and a different development orientation). The process is based on the integration of the works of Keen and Scott Morton (1978) and Meador *et al* (1984b) and the various phases are now described:

- **Phase 1: Planning.** Planning deals primarily with a needs assessment and problem diagnosis. Here the goals and objectives of the decision support effort are defined and a crucial step in the planning effort is determining the key decisions of the DSS. Two points need to be emphasized regarding these key decisions. Firstly, the DSS is only a tool providing information to the manager. Secondly, although it may be difficult to provide relevant information for a decision, it is still crucial to identify the key decisions;

- **Phase 2: Research**. This phase involves the identification of an appropriate approach for addressing user needs and available resources. These include hardware, software, systems, studies or related experiences in other organisations, vendors and a review of relevant research. In this phase the DSS environment is closely checked;
- **Phase 3: Analysis and Conceptual Design**. This phase includes the determination of the best approach and specific resources required to *implement* it. The resources include technical, financial, staff and organisational. Turban (1995) suggests that this is basically a conceptual design followed by a feasibility study;
- **Phase 4: Design**. The detailed specifications of the system components, structure and features are determined in this phase. The design can be divided into four parts corresponding to the major components of a DSS: database and its management, model base and its management (the problem-solving component of the DSS), knowledge management subsystem and dialog subsystem. See section 4.2. The appropriate software tools (*e.g.* database manager and a spreadsheet) are selected or written. A major issue in the design effort is deciding which commercially available software is best to use;
- **Phase 5: Construction**. A DSS can be constructed in different ways. This is dependent on the design philosophy and the tools being used. The construction is the *technical* implementation of the design. This is, however, excluded from this research. During this

phase, the DSS may be connected with appropriate networks and IS; and

- **Phase 6: Implementation**. At the end of the construction phase, the system is ready for implementation. As this topic is the focus of this research, it will be discussed separately in the next section and revisited in Chapter 6.

The development efforts concludes with two additional phases: maintenance and adaptation:

- **Phase 7: Maintenance and Documentation**. The maintenance phase involves planning for ongoing support of the system and its user community. Correct documentation for using and maintaining the system is also developed; and
- **Phase 8: Adaptation**. Adaptation necessitates a recycling through the earlier steps on a regular basis to respond to user needs. As previously indicated, these steps are not linear (*i.e.* there are cycles and loops).

## 4.8 What is *Implementation*?

Implementation is the activity of using selected tools to transform DSS designs into operational systems (Holsapple and Whinston, 1996). The definition of implementation is somewhat complicated because implementation is a long and involved process whose boundaries are vague (Turban, 1995). As this research focuses on this phase, detailed discussion of implementations (with specific reference to DSS implementations) will be undertaken in Chapter 6. At this stage, in a simplistic manner, *implementation* may be defined as putting a recommended solution to work. Many of the generic issues of implementation (*e.g.* degree of top management support, user training) are important in dealing with IS and these will also be dealt with in Chapter 6.

The implementation phase consists of the following tasks: testing, evaluation, demonstration, orientation, training and deployment and several of these tasks occur simultaneously and are constructed in the field:

- **Training**. In this phase, data on the systems' outputs is collected and compared against the design specifications;
- **Evaluation**. During this phase, the implemented system is evaluated to see how it meets with the users' needs. Technical and organisational "loose ends" are also identified for resolution. Evaluation is particularly difficult with a DSS as the system is continually being modified or expanded and thus does not have a neatly defined set of completion dates or standards for comparison. The testing and evaluation, which usually result in changes in the design and in construction, results in a cyclical process which repeats itself several times;
- **Demonstration**. The demonstration of the fully operational system capabilities to the user community is an important phase as viewers can become believers. As a result they accept the system with little or no resistance;
- **Orientation**. This involves the instruction of the managers in the basic capabilities and operation of the system;
- **Training**. Operational users are trained in system structure and functions. Users are trained also trained how to maintain the system; and
- **Deployment**. The full system is then operationally deployed to all members of the user community.

## 4.9 Evaluation of DSS Success

The evaluation of DSS suffers from the same difficulties as does the initial assessment of the desirability of developing the DSS (Sprague and Watson, 1996). Specifically it is difficult to determine the benefits from improved decision-making due to DSS. The researchers indicate that there are two basic approaches that management can employ in evaluating the success of DSS - the formative evaluation and the post implementation audit.

According to Athappilly (1985), the formative evaluation consists of four phases:

- domain evaluation which calls for a nonquantitative, expert examination of the project prior to development;
- design evaluation is descriptive in nature and defines the essential components to be developed in the DSS;
- implementation evaluation examines the DSS design and provides feedback for modifications; and
- outcome evaluation compares the goals of the DSS with the resulting product.

Sprague and Watson (1996) contend that the more common form of evaluation of DSS success is the post-implementation audit. This is the form of evaluation will be adopted in this research and will be discussed more fully in Chapter 6. This evaluation is similar to the outcome evaluation of the formative evaluation process. Traditionally, the post-implementation audit of IS takes the form of structured cost-benefit analysis (or other similar procedures). This will be discussed in section 6.10.2. However, as Sprague and Watson (1996) indicate, often the qualitative nature of decision improvement resulting from the DSS typically results in an intuitive assessment of system success. One approach which has been recommended specifically for the evaluation of DSS success, considers elements which are measurable and are common sense (Welsch, 1990). These measures include perceived satisfaction of management with the "final" product, frequency of use (if use is voluntary) and acceptability of the DSS to management. In this study this approach has been adopted during the design of a suitable and appropriate measuring instrument.

## 4.10 The Impact of DSS on Management

Faced with an increasingly complex world, managers today are deciding that they need access to the information which is pertinent to their particular responsibilities and roles (Bullen and Rockart, 1981). One method of determining precisely what information is most needed is the "critical success factors" (CSF) method. This method will be discussed in detail in Chapter 5. Clearly, the most obvious impact of DSS on management is an improvement in decision-making. DSS provide better access to information and in particular better access to models. This in turn permits an examination of the options which exist but which were less amenable to analysis without computer support. Specifically, a DSS can increase the number of alternatives evaluated, improve confidence in decisions and greatly speed up the decision-making process. In today's business environment, computer support is a universal requirement as it is needed by all levels of management.

There is another aspect of DSS utilisation which affects management - the basic nature of what managers perform on a regular basis. Upper level managers are now interacting directly with computer output and as Sprague and Watson (1996) note, in many cases with the computer itself. This hands-on utilisation of computers by senior management generally has a very positive effect on their perceived value of IS to the organisation. Middle management may be the most significantly affected category of management because they often fulfil multiple roles with regards to DSS. Firstly, they develop and use their own DSS and this are affected in the same ways as upper management. Secondly, as middle managers often serve as intermediaries to upper managers, they often become project leaders for critical, corporate level projects thereby providing valuable cross-departmental experience. This experience is both functionally and in the development of computer-based applications.

The involvement of managers in DSS is greater than their involvement with other kinds of IS applications (Sprague and Watson, 1996). Management is actively involved with the approval, development and operation, administration and use of DSS. This direct involvement becomes possible with the use of development tools, the frequently narrow scope of the applications being developed and other factors. The importance of the DSS to the manager's decision-making tasks and the involvement of the manager and staff generally, results in a sense of ownership of the DSS which then results in overall administrative control of the application.

## 4.11 Summary

In this chapter, the four subsystems (data management, model management, communication and knowledge management) of a DSS were discussed. A recent "new" subsystem, MMS, was also described.

An overview of the DSS user, hardware and software was given. The classifications of DSS and their support with a focus on institutional versus *ad hoc* DSS was discussed. DSS technology levels and the DSS development process were described. The term "implementation" was then discussed. Finally, an evaluation of DSS success and the impact of DSS on management was noted.

# Chapter 5

## A CRITICAL SUCCESS FACTORS PERSPECTIVE

### 5.1 Introduction

The use of the CSF concept as an IS methodology was first introduced by John Rockart as a mechanism for defining a CEO's information needs (Rockart, 1979). For any organisation, CSFs are the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for an organisation (Thierauf, 1982). This researcher states that they are the few key areas where **things must go right** if the organisation is to flourish. This is underscored by Fidler and Rogerson (1996) who explain that CSFs are "those small number of critical areas where things must go right for the organisation to prosper". Turban *et al* (1999) note that if "these functions are well, the organization will do well". Should the results in these areas be not adequate, the organisation's efforts for the period will be less than desired. Consequently, the CSFs are areas of activity that should receive constant and **careful attention from management**. The current status of performance in each area should be continually measured. This information should then be made available to higher levels of management (Thierauf, 1982).

The CSF method has attracted considerable attention as a means of supporting both MIS planning and requirements analysis (Boynton and Zmud, 1984). Although the researchers indicate that experiences in applying the CSF method have been quite favourable, there was some debate about the strengths, weaknesses and appropriate use of CSFs as an IS methodology. More recently, researchers Fidler and Rogerson (1996) claim that the CSF approach has gained widespread popularity within IS strategy development largely due to its intrinsic conceptual simplicity and to it requiring relatively few resources to utilise.

The CSF approach as developed as a way of investigating the information requirements of executives within organisations and was expanded by Bullen and Rockart (1981) into a Strategic Information Systems Planning (SISP) methodology. This early work has been modified and expanded upon (Fidler and Rogerson, 1996). For example, Martin and Leben (1989) describe in detail a working version of the methodology. CSF analysis has become an integral part of many of the approaches of leading consulting firms (*e.g.* Andersen Consulting). As Martin and Leben (1989) state

> "Critical success factors, and their associated information systems and [management] support systems ..... become a vital part of the ongoing process of management".

In this chapter the CSF methodology will be discussed and the strengths and weaknesses of the CSF method will be given. CSFs in information resource planning, information function planning and applying CSFs to IS requirements analysis will be discussed. The rationale and benefits for using the CSF method will be elaborated.

Finally, the use of the CSF concept specifically in the DSS environment will be discussed.

## 5.2 The CSF Concept

Rockart's CSF concepts were developed from the ideas stated much earlier by Daniel (1961). Rockart did not specifically advocate using the CSF method to develop a detailed set of requirements specifications but rather to identify the critical areas of concern and to provide initial descriptions of information measures that reflect these critical areas. He stressed two points:

- CSFs provide a focal point for directing an IS development effort; and
- the CSF method should result in an IS useful to a CEO as it pinpoints key areas that require a manager's attention.

Rockart (1979) defines "critical success factors" as "those key areas of activity in which favorable results are **absolutely necessary** for a particular manager to reach his or her goals" (bold text added by author). This was later refined by Bullen and Rockart (1981) who state the following

CSF definition:

> "CSFs are the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department, or organisation. CSFs are the few key areas where "things must go right" for the business to flourish and for the manager's goals to be attained".

In essence this means that CSFs are those few things that must go well to ensure success for a manager or an organisation and therefore they represent those managerial or enterprise areas that must be given *special* and *continual* attention to bring about high performance (Boyton and Zmud, 1984). The key to success for most managers is to focus their most limited resource (their time) on those aspects which really make the difference between success and failure (Bullen and Rockart, 1981). Rockart (1982) warns that the "mere statement that things are critical is not enough". There must be processes in place to ensure that significant managerial attention is given to critical areas. CSFs include issues that are vital to an organisation's current operating activities and to its future success (see, for example, Rockart and Treacy, 1982).

Turban *et al* (1999) report that critical success factors which *must* be considered in attaining the organisation's goals, are called CSFs. Such factors can be strategic, managerial or operational and are derived mainly from three sources: organisational factors, industry factors and environmental factors. Success factors can be at the corporate level and at other levels (division, plant or department).

The CSF methodology is a procedure that attempts to make explicit those few key areas that dictate organisational or managerial success. CSFs emerge from structured dialogues (interviews) between a skilled CSF analyst (or researcher) and key personnel of an organisation. CSFs should be elicited from managers who represent a cross-section of the organisation's major functional areas. For the purposes of this research, a manager from the DSS functional area of different organisations was chosen. This provided a collection of consistently referenced CSFs which could be refined into a set of industry CSFs for DSS implementation in KwaZulu-Natal.

Bullen and Rockart (1981) later broadened the definition of CSFs and proposed that they be used as an MIS planning tool. Munro and Wheeler (1980) suggest that CSFs can be used to direct an organisation's efforts in developing strategic plans. In addition to applying CSFs to fabricate a set of strategies, they can also be used to identify critical issues with *implementing* a plan (author's own italics). Thierauf's (1982) experience with CSFs suggests that they are highly effective in help top management and the corporate planning staff to define their significant strategic information needs. Anderson (1984) notes that CSFs can be used by managers and organisations to help achieve high performance. Managers must continually receive information about the current level of performance in each of the critical areas as a basis for decision-making (Holsapple and Whinston, 1996). Ward and Griffiths (1997) report that the current status of performance in each area.should be continually measured and that information should be made widely available.

## 5.3 Qualities of the CSF Method

Boynton and Zmud (1984) report that the CSF method has been cited for weaknesses in three main areas:

- **Appropriateness**. It has been asserted that the CSF method is difficult to use and is therefore not appropriate for organisations whose analysts do not possess the capability to successfully apply the method. Whilst this may be true that the CSF method must be directed by a skilled analyst, Boynton and Zmud (1984) contend that this statement can be made about all non-automated IS methodologies;
- **Validity**. The validity of the CSF method has been questioned because of the threat of the analyst and manager bias introduced through the interview process. However, Munro's (1983) studies showed that independent CSF analyses yielded comparable results; thus indicating that these potential biases can be overcome. In this DSS research, there was no element of bias as the interviewer (the author) was not associated with any of the organisations; and
- **Applicability**. Davis (1979) raises several concerns regarding the applicability of the CSF method as an appropriate requirements analysis methodology. He argues that as humans have a limited capacity to deal effectively with complexity, the CSF

method may very well yield an information model that is simple and thought provoking but not accurately representative of the environment.

The research of Boynton and Zmud (1984) suggest that two key strengths of the CSF method contribute much to its success:

- **Acceptance**. The CSF method generates user acceptance at the senior management level. Senior managers seem to intuitively understand the thrust of the CSF method. Consequently they strongly endorse its application as a means of identifying important areas that need attention; and
- **Planning**. The CSF method favours a planning process. It initially focuses a particular applicant's attention on a core of essential issues and then proceeds to refine the issues in a manner that allows an evolving "design" to be continuously examined for validity and completeness.

The researchers' case studies provide support for these two assertions regarding the CSF method and indicate that CSFs can be used for both IS planning (see section 5.5) and requirements analysis (see section 5.6).

## 5.4 CSFs in Information Resource Planning

At an operational level, CSFs help ensure that critical organisation information processing needs are explicitly addressed (Boyton and Zmud, 1984). The development of organisational CSFs and their use as a guideline for bounding and directing implementation efforts also provide a means to improve the overall integration of IS efforts. CSFs thus form a bridge between corporate strategic interests and the strategic planning efforts of the information function. Since an organisation's CSFs are those factors that must go well for the organisation to succeed, a link is provided between an organisation's tactical and strategic planning objectives. Furthermore CSFs enhance communication between the organisation's general management and those individuals responsible for deploying information resources by providing a common platform which both groups can easily comprehend. The researchers report that the CSF method also seems very adept at establishing a mutual understanding between managers and analysts which enhances the IS department's image and improves their usefulness to the organisation.

## 5.5 CSFs in Information Function Planning

The CSF approach helps to identify the information needs of managers (Turban *et al*, 1999). This can be an important tool in an analyst's repertoire. Strategic and policy roles for CSFs within the information function planning context revolve around their use as a tool **to identify those issues that merit close management attention** within the information function itself. Since the information function planning must be sensitive to both changing technical and organisational environments, the CSF approach surfaces key issues that must be addressed in managing change within information function policy (Boyton and Zmud, 1984). The CSF approach encourages managers to identify what is most important to their performance and then develop good indicators of performance in these areas (Turban *et al*, 1999).

According to Ward and Griffiths (1997), CSFs enable management to use their judgement in two ways:

- to assess the relative importance of systems opportunities in terms of how well they support the achievement of business objectives; and
- to identify the information required by management to manage and plan business executives' information needs. As they indicate, it is always better to have a crude measure of something important rather than a refined measure of something that does not matter! CSFs help to differentiate the two.

## 5.6 CSFs applied to Requirements Analysis

Rockart (1979) initially advocated the use of CSFs both for conceptually identifying a manager's key concerns and for developing specific measures that capture a manager's information needs. This implies that Rockart suggested that CSFs are applicable to both the conceptual and the detailed design phases of the requirements analysis process. CSFs therefore appear valuable as a means of building a conceptual model of an organisation or of a manager's role in an organisation. Such a model can then be used to drive the requirements analysis process.

## 5.7 Rationale for Using the CSF Method

CSFs are flexible and do not require a rigorous format in their use on interpretation (Boyton and Zmud, 1984). A disadvantage is that the flexibility of CSFs may lead to an overly casual approach to their application. If this occurs, the CSFs will communicate invalid signals to both analysts and users.

The researchers state that there are two major findings regarding the use of the CSF method as an appropriate IS methodology:

- CSFs can induce a structured design process for eliciting both IS plans and managerial information needs. This structured approach lends a sense of consistency and completeness to these IS efforts by emphasizing and then refining important organisational or managerial issues; and
- CSFs are generally more useful in IS planning than in requirements analysis. A successful CSF-led requirements analysis effort is likely to be supported by other "more concrete techniques".

CSF analysis is a powerful and "deservedly popular technique" in IS strategy planning and business planning (Ward and Griffiths, 1997).

## 5.8 Benefits of CSFs

Thierauf (1982) notes that in addition to use by top management and the corporate planning staff, CSFs are useful at each level of general management. The researcher summarises the following significant benefits of CSFs:

- the process helps the manager determine those factors on which he should focus management attention. It also helps to ensure that those significant factors will receive careful and continuous management scrutiny;
- the process forces the manager to develop good measures for those factors and to seek reports on *each* of those measures;
- the identification of CSFs allows a clear definition of the amount of information that must be collected by the organisation and limits the expensive collection of more data than necessary;
- the identification of CSFs moves an organisation away from the trap of building its reporting and IS primarily around data which is "easy to collect". Instead it focuses attention on that data which might otherwise not be collected but is significant for the success of the particular management level involved; and
- the process acknowledges that some factors are temporal. He suggests that the computerised system (*i.e.* a DSS) should be capable of producing new reports to accommodate changes in the organisation's CSFs.

Ward and Griffiths (1997) state that CSF analysis is a most effective technique involving senior management in IS planning as it is wholly rooted in business issues and in gaining their commitment to proposed IS actions that contribute to achievement in critical areas. For example, for EIS, the CSF method is the most frequently mentioned approach of the methods that determine information requirements based on the characteristics of the object system (Sprague and Watson, 1996). However, Burkan (1992) cautions that not all users of the CSF methodology report success.

Sprague and Watson (1996) indicate that the CSF process can also be used to identify critical failure factors (CFFs). These are developments which can significantly impair performance (*e.g.* a strike or environmental damage are potential CFFs for many organisations). Even though a CFF may not come to mind readily when thinking of success, its occurrence can have disastrous consequences.

## 5.9 The CSF Concept in the DSS Environment

Turban (1995) states that "it is necessary to identify the critical factors and structure the appropriate system **before** developing the MSS" (bold text added by author). DSS is one of these MSS technologies and the focus of this research. In addition to CSFs being used in determining information requirements, CSFs have been used in feasibility studies of MSS and in other phases of the development process of these techniques. For example, it was used in DSS software selection (see Shank *et al*, 1985).

A unique strength of the CSF method is that it takes into account the changing environment with which organisations and managers must deal (Laudon and Laudon, 1998). As they indicate, this method explicitly asks managers to look at the environment and consider how their analysis of it shapes their information needs. The researchers state that it "**is especially suitable** for top management and **for the development of DSS** and ESS" (bold text added by author). They add that "**the CSF method seems to apply only to management reporting systems, DSS**, and ESS" and it assumes that successful TPS already exist (bold text added by author).

The successful implementation of a DSS is not a trivial issue (Liang, 1986). As a number of factors play roles in the DSS implementation process, the risk of failure is high unless the process is well managed. In order to reduce the risk of failure, a cardinal question Liang seeks to address in his research entitled "Critical Success Factors of Decision Support Systems: An Experimental Study" is "What are factors affecting successful DSS implementation?". Clearly, such factors are *critical* to the *successful* implementation of DSS. Before the previously identified CSFs for DSS are discussed in Chapter 7, a look will be taken at IS implementations and DSS in Chapter 6.

## 5.10 Summary

In Chapter 5 the CSF concept was explained. The strengths and weaknesses of the CSF method were given. CSFs in information resource planning, information function planning and applying CSFs to IS requirements analysis were discussed. The rationale and benefits for using the CSF method were noted. Finally, the use of the CSF concept in the DSS environment was discussed.

# Chapter 6

## IS IMPLEMENTATIONS AND DSS

### 6.1 Introduction

Implementation is the introduction of change (see section 4.8). The successful implementation of any IS depends on many social, environmental, behavioural, economic, technical and organisational factors. What determines the successful (or failure) of an IS and specifically a DSS? This chapter seeks to explore some of these factors. Some technical factors will be discussed, however, specific focus will be on the non-technical aspects associated with DSS implementations.

### 6.2 Implementation: Concepts of Success and Failure

#### 6.2.1 What is Implementation?

The term "implementation" has briefly been discussed in section 4.8. The definition of implementation is complicated because implementation is a long, involved process with vague boundaries. Keen and Scott Morton (1978) note that DSS implementation "will never be easy". Implementation can be defined simplistically as getting a newly developed (or significantly changed) system to be used by those for whom it was intended (Turban, 1996).

The implementation of a DSS is an ongoing process that takes place during the entire development of the system - from the original suggestion through the feasibility study, systems analysis and design, programming, training conversion and installation of the system. In sharp contrast, IS professionals often refer to the implementation as only the final stage in the system's life cycle. Consequently, for DSS the definition is more complicated because of the iterative nature of their development. If the DSS is intended for repetitive use, then implementation means a commitment to routine and frequent use of the system *i.e.* institutional. In the case of *ad hoc* decisions, implementation means the one-time use of the system.

The implementation of DSS is complex because these systems are not merely IS that collect, manipulate and distribute information. Instead, they are linked to tasks that may significantly change the manner in which organisations operate. Nevertheless, as Turban (1996) notes, many of the implementation factors are common to any IS.

### 6.2.2 Measuring Implementation Success

No single measure of IS success is really appropriate and none has found full acceptance (Finlay, 1993). Garrity and Sanders (1998) indicate that it is important to note that many IS have multiple functions including transaction processing and decision support. They suggest that IS should be evaluated in terms of:

- task support satisfaction;
- decision-making satisfaction;
- interface satisfaction; and
- quality of work life satisfaction.

The researchers' stance is that an IS may be successful on one or more dimensions and that the dimensions of success are interdependent. For example, a DSS to assist an international currency dealer could be evaluated in terms of the quality of the user interface, the degree to which it assists in making currency decisions and the way the system impacts the trader's quality of work life.

As experience with DSS has grown, Laudon and Laudon (1998) state that the DSS success factors are not very different from those of MIS and other systems. They report that several studies have noted that user training, involvement and experience, top management support, length of use and novelty of the application were the most important factors in DSS success. *Success* is defined as perceived improvement in decision-making and overall satisfaction with the DSS (see, for example, Alavi and Joachimsthaler, 1992; and Sanders and Courtney, 1985).

The definition of implementation includes the concept of success (or failure). A number of possible indicators for a successful IS have been suggested in various implementation studies (see, for example, Laudon and Laudon, 1998). Unless a set of success measures is agreed on, it will be difficult to evaluate the success of a system.

In evaluating the success of DSS, Turban (1995) suggests that some measures of success are:

- user satisfaction measured by interviews or questionnaires (see Swanson, 1988);
- favourable attitudes (either as an objective by itself or as a predictor for use of a system);
- degree to which a system accomplishes its original objective (*e.g.* assists the manager in his decision-making processes);
- benefit to cost ratios;
- payoff to the organisation through increased sales, cost reductions, *etc*; and
- degree of institutionalisation of DSS in the organisation.

For a detailed technical approach to DSS evaluation, see Adelman (1992).

### 6.2.3 Partial Implementation

Turban (1995) states that feasibility decisions are often made on the basis of the payoff if *total* implementation is achieved. However, he adds that in reality a 90 percent (or even 70 percent) implementation is likely. A reason for less than 100 percent implementation is that a change introduced at one point in the system may precipitate compensatory and possibly negative impact elsewhere. Management may then discard those parts of the project that created the negative impacts. Consequently, less than 100 percent of the original project is implemented.

6.2.4 Implementation Failure

The implementation of IS involves several problems that have been subject to extensive research (see, for example, Meredith, 1981; and Lucas, 1981). However, there is very little evidence available to substantiate the true extent and magnitude of these problems. For example, Yorman (1988) and Keyes (1989) note that ES fail at an "extremely high rate". The actual information in implementation failures is often a closely guarded secret in many organisations especially when large sums of money have been spent on unimplemented systems (Turban, 1995).

IS "failures" are not necessarily falling apart but either they are clearly not used in the way they were intended or they are not used at all (Laudon and Laudon, 1998). The researchers indicate that an IS will be judged a failure if its design is not compatible with the structure, culture and goals of the organisation as a whole. In the case of the Adaptive Interpersonal Use Model (Swanson, 1988) the essential feature of this model is the notion that each manager adapts uniquely to an IS. Certain managers use the system directly whilst "others choose to be other-users, receiving the reports provided by intermediaries or other managers". The researcher notes that "still others are active in both roles".

The Davis Technology Adoption Model (TAM) suggest that the degree to which a technology will be adopted is an interplay between its perceived usefulness and its perceived ease of use (Sumner and Varden, 1998).

Heeks (1998) identifies four main forms of IS failures:

- the *total failure* of an initiative never implemented or in which a new system is implemented but immediately abandoned;
- the *partial failure* of an initiative in which major goals are unattained or in which there are significant undesirable outcomes;

- the *sustainability failure* of an initiative that succeeds but then fails after a year or so; and
- the *replication failure* of an initiative that succeeds in one place but cannot be repeated elsewhere.

The researcher indicates that there is a need to understand why these failures occur and "why less frequently, there are successes".

Researchers Dickson and Wetherbe (1985) state that frequently the absence of conditions necessary for successful implementation result in "tactics of counterimplementation (*sic*)". Counter implementation at managerial levels includes:

- deflecting the goals of the project;
- diverting resources from the project;
- dissipating the energies of the project; and
- neglecting the project with the hope that it will go away.

At the operational level, tactics of counter implementation take the form of:

- making errors on purpose;
- using the system for purposes other than those for which was intended;
- failing outright to use the system; and
- relying, wherever possible, on old manual procedures.

Even an initial *attempt* to implement an IS may trigger a failure. This is underscored by Mohan and Bean (1979) wherein the researchers note that there is considerable evidence in organisations which "experience *severe internal disruptions and change*, as the new technology is introduced". They add that in some cases the reactions have been adverse enough to result in a temporary rejection of the technology for a period of three to five years. As Turban (1995) adds, the initial failure not only postpones progress for a number of years but it also may make later attempts likely to fail.

From the literature survey, there is not much formal data available on DSS failures. However, there are many informal reports on unsuccessful implementation. Why such systems fail and the necessary conditions to minimize failures are dealt with later in sections 6.4 - 6.10 inclusive. The identified factors, which are critical for successful implementation of DSS, were selected from two implementation frameworks. These are then discussed in detail in Chapter 7.

## 6.3 Research on Implementation

The importance of the implementation problem in IS has led to extensive research about the determinants of successful implementation (see, for example, Alavi and Joachimsthaler, 1992; and Lucas, 1995). Research commenced several years ago with studies conducted by behavioural scientists to examine resistance to change to technological innovations. Further discussion on this "resistance to change" theme will be given in section 6.6. The management science movement has been occupied with this issue since the late 1950s. MIS researchers have been studying implementation issues for nearly three decades and this topic will be further discussed in sections 7.1 and 7.2.

### 6.3.1 Measures for Rating Systems Success

MIS researchers have looked for a formal set of measures for rating systems success. According to Laudon and Laudon (1998), the following are considered the most important:

- **High levels of system Use**. This is measured by polling users or employing questionnaires;

- **User Satisfaction with the System**. This is measured by interviews or questionnaires and may include users' opinions on the accuracy, timeliness and relevance of information. Especially critical are managers' attitudes on how well their information needs were satisfied (Ives *et al*, 1983; and Westcott, 1985) and users' opinions regarding how well the system enhanced their job performance (Davis, 1989);
- **Favourable Attitudes**. This relates to users regarding IS and IS staff;
- **Achieved objectives**. This is the extent to which the system meets its specified goals as reflected by improved organisational performance and decision-making resulting from use of the system; and
- **Financial Payoff**. This is achieved by either reducing costs or by increasing sales or profits to the organisation. This measure is considered to be of "limited value" as the benefits of an IS may not be totally quantifiable (Laudon and Laudon, 1998). MIS researchers prefer to concentrate on the human and organisational measures of system success as information quality, system quality and the impact of systems on organisational performance (Lucas, 1981; and DeLone and McLean, 1992). The topic of financial payoff (*i.e.* cost-benefit analysis) will be further discussed in section 6.10.2.

A considerable number of implementation ideas and theories have been accumulated. Several models for implementation have been proposed for IS (see Lucas, 1995; Meredith, 1981; and Swanson, 1988). However, there are fewer models specifically designed for DSS (see, for example, Guimaraes *et al*, 1992; and Kivijärvi and Zmud, 1993). As there has been a large failure rate of knowledge-based DSS (and ES), research undertaken has attempted to analyse the problems and prescribe remedies (see, for example, Barsanti, 1990; and Medsker and Liebowitz, 1994).

### 6.3.2 Variables associated with Implementation Studies

Turban (1996) states that many ("several dozen") factors can determine the degree of success of DSS. He indicates that the words "a factor" or "a success factor" refer to a condition present in the organisation (*e.g.* the support of top management) or to the specific application (*e.g.* the use of appropriate software). Success factors may be divided into two categories: the generic factors that are related to any IS and those that are specifically related to decision support technologies.

Most research on implementation has been geared to discover factors associated with success *i.e.* what independent variables are related to successful implementation as defined by the researchers. This forms the basis of this research. If there is any basis for believing that a casual connection exists between independent and dependent variables, an implementation strategy may be developed around the independent variables (Turban, 1996). He cites the example whereby "top management's requesting a new system and following through with participation in its design" is associated with "successful implementation". Then, if there is sufficient evidence to support this finding, an implementation strategy may be developed that emphasizes such top management action. The topic of top management support will be dealt with in sections 6.7.1 and 9.3.2.

Although individual studies of implementation have addressed a number of independent variables, there appears to be no consensus in the field on an explanation of successful implementation or on a single implementation strategy (Lucas, 1986a).

Figure 6.1 shows some of the variables associated with previous implementation studies. Dependent variables used to measure implementation success may be classified as *measures of use*, *intended use*, and/or *satisfaction with a system*.

**Figure 6.1 Variables associated with Implementation Studies**

| INDEPENDENT VARIABLES | |
|---|---|
| **Information Services department**<br>Policies<br>Systems design practices<br>Operations policies | **User attitudes**<br>Expectations<br>Interpersonal relations |
| **Involvement**<br>User origination of systems<br>Involvement and influence<br>Appreciation | **Systems characteristics**<br>Quality<br>Ease of use |
| **User demographics**<br>Personality type<br>Business history<br>Social history<br>Past experience | **Decision style**<br>Cognitive style |
| **User's personal stake**<br>Problem urgency | **Management**<br>Actions<br>Support<br>Managerial style |
| **Organisation support**<br>Ease of access | **User performance** |
| **DEPENDENT VARIABLES** | |
| **Implementation**<br>Frequency of enquiries<br>Reported use<br>Monitored frequency of use<br>User satisfaction | |

(Source: Adapted from Lucas, 1986a)

As shown in Figure 6.1, the independent variable falls into several classes. The manner in which the independent and the dependent variables are related, is the subject of interest of implementation frameworks and will be discussed in Chapter 7.

## 6.4 Technical Factors

Technical factors for DSS implementations do not form part of this research, however, a summary of these factors is given. Technical factors relate to the *mechanics* of the implementation procedure. Some of technical factors are:

### 6.4.1 Level of Complexity

To maximise the likelihood of successful implementation, the maxim is to keep the system as simple as possible. The advantages of simplicity for implementation success are many: fewer errors, integrity of design, easier user training, simpler data requirements, ease of control, managerial transparency and speed of installation. However, caution must be exercised that there is harmony with another desirable system characteristic: correctness of critical aspects.

### 6.4.2 System Response Time and Reliability

Situations wherein either the system reacts too slowly, crashes or is not available (when needed), have been known to create user dissatisfaction. Response time, if inadequate, can be improved by faster hardware, program tuning and database and network optimisation (Mallach, 1994).

### 6.4.3 Inadequate Functions

Limited personal computer memory, undersized hard drive storage capability, an imbalance between hardware and software capabilities, poor graphics, complex text manipulation, user unfriendliness and the inability to deal rapidly with changing situations are all examples of inadequate functions which tend to discourage users.

In addition to these technical issues, there are other related issues: lack of equipment, lack of standardisation, network problems (*e.g.* connectivity), mismatch of hardware/software and a low level of technical capacity of the project team. None of these issues will be dealt with any further.

Technical issues can be classified into two distinct categories:

- **Technical constraints**. These are mainly due to the limitations of the available technology. However, they may disappear when new technologies are developed; and

- **Technical problems**. These are *not* the result of technology but are caused by other factors (*e.g.* scarcity of resources). These problems can be overcome by increasing available resources.

Even though DSS technical conditions are considered important, DSS researcher, Peter Keen, indicates that for the successful implementation of DSS "far more critical is the designer-user relationship. Without that, the best technical system rarely actually gets used." (Keen, 1998).

## 6.5 Behavioural Factors

The implementation of IS in general and DSS in particular is affected by the way people perceive these systems and how they behave (Turban, 1995).

### 6.5.1 Decision Styles

Individuals make decisions and they have different styles. They may use different approaches to making decisions, a different sequence of the same steps in the process or the same sequence but with these steps emphasized differently. A popular explanation why people make decisions differently is that they possess different cognitive styles. A classic distinction is the one between the heuristic and analytical styles. For details on how decision styles relate to DSS and the provided support, see Wedley and Field (1984).

According to Powell and Johnson (1995), DSS are currently either constructed upon the assumption of an androgynous user or "incorporate constructors' implicit biases". However, if males and females take decisions in different ways or prefer different styles of information, then their *use* of DSS may differ.

### 6.5.2 Organisational Climate (Culture)

If the organisational climate of a company is hostile to innovation, it may be difficult to introduce changes. If the attitudes of organisational members are poor towards attempts to introduce IS, then introducing a DSS may even be more difficult. However, if there is an openness in the organisation so that values and opinions are shared, change can be facilitated. Organisational change researchers speak of a climate that supports mutual trust between the developers of a system and the potential users. See Benjamin and Levison (1993).

Turban (1995) reports that the influence of senior management is vital in determining organisational culture. Where the climate is poor, steps must be taken to improve matters before any attempt is made to introduce change.

### 6.5.3 Organisational Expectations

During the past decade, much publicity has been given to ES, AI and ANN. Consequently, now the expectations by top management and users may be too high. Turban (1995) warns that over-expectations may be dangerous to the success of any system. This may be especially true for initial applications in which the strategy may be to sacrifice potential payoff and speed for effectiveness and quality. If there is an expectation of quick and large savings and these are not forthcoming, people will not continue to support such ventures. Holsapple and Whinston (1996) indicate that some organisations develop DSS because they are viewed as "organizational winners" or because management has mandated the use of a system. The researchers caution that a DSS will not solve all the problems of any given organisation but "it does solve some problems well".

### 6.5.4 Organisational Politics

The prevalence of "politics" in organisations (especially large ones) is often underestimated or ignored. However, as Turban (1995) reports the successful implementation of a project may well depend on politics. The DSS team leader should be advised not to remain neutral but to become involved, learn the rules and ascertain the power centres and cliques of the organisation. For further discussion, see Markus (1983).

## 6.6 Resistance to Change

### 6.6.1 Dimensions of Change

The introduction of a new technology into an organisation will almost certainly result in some change (see, for example, Dickson and Wetherbe, 1985). The changes that result from implementing MSS can be technical, social, structural, psychological or a combination of these factors. Managers often feel threatened by modern techniques of analysis and may sense that a computerised project may take over or jeopardise their job. Furthermore Turban (1995) states that fears relating to computers (computer phobia) still exist. Top management may think that such beliefs are absurd. What actually governs the user's behaviour is not so much the real threat as the *perceived* threat. A good way for the system introducer to cope with the fear of change is to endeavour to eliminate this perceived threat.

### 6.62 Overcoming Resistance to Change

The topic of dealing with resistance to change has many dimensions but is not discussed here. Change management is emerging as an important discipline for technologically oriented organisations (see, for example, Fallik, 1988; Morino, 1988; and Benjamin and Levinson, 1993).

Turban (1995) contends that managing change can enhance successful implementation. Several theories have been developed on how to accomplish this. A widely publicised one is by Lewin and Schein. See Lewin (1947). The researchers focus on the *process* by which change takes place, The Lewin-Schein Theory of Change is a concise description of this process and the theory states that change consists of three steps:

- **Unfreezing**. Creating an awareness of the need for change and a climate of receptivity to change;
- **Moving**. Changing the magnitude or direction of the forces that define the initial situation; developing new methods and/or learning new behaviours and attitudes; and

- **Refreezing**. Reinforcing the changes which occurred, thereby maintaining and stabilising a new equilibrium situation.

The Lewin-Schein Theory of Change has been used as a change-planning basis to indicate strategies to handle resistance to change in IS (see, for example, Dickson and Wetherbe, 1985). This theory of planned change was adapted to DSS by several researchers (see, for example, Alter, 1980; and Guimaraes *et al*, 1992, who studied the DSS implementation process in its entirety and identified the refreezing phase as being of special importance to IS project success or failure). As Turban (1995) notes, in DSS the refreezing phase is especially important because the user must initiate the interaction with the system and DSS is expected to impact on the decision-making process of users. As the relationship between a DSS and its users evolves simultaneously, so are the design and implementation of a DSS an ongoing process. Clearly the role of the intermediaries (who serve as integrating change agents and as human interfaces between the decision makers and the DSS) in the refreezing phase, can play a major role in implementing DSS. They are, however, not researched here.

## 6.7 Process Factors

The manner in which the process of developing and implementing MSS greatly influences the success of implementation to a large extent. Topics which are relevant to process factors are top management support, management and user commitment, institutionalisation and the computer proficiency of users. Each of these is now discussed.

### 6.7.1 Top Management Support

Top management support has long been recognised as one of ***the*** (italics used by Turban, 1995) most important ingredients for the introduction of any organisational change. Meredith (1981) cites nineteen references that support this phenomenon in IS. This factor will be reported on in the findings of this research. See section 9.3.2.

Clearly, if top management support advocates and devotes full time to a system, the chances of successful implementation are enhanced. However, the support from top management must be meaningful and top managers must know about the difficulties of the project and the amount of time and resources required to support it. Obviously such support is more likely if the managers have had previous experience with similarly sophisticated projects. Turban (1995) warns, however, that there is a danger in advocacy when the support comes from one person. If he is transferred or leaves, the support may disappear. Thus, top management support must be broad based to be meaningful.

Even though there are no specific studies in the literature dealing with methods to increase top management support for DSS, there are several recommendations related to IS in general. See, for example, Rockart and Crescerzi (1986) and Young (1987).

### 6.7.2 Management and User Commitment

Support means understanding issues, participating and making contributions. However, it is significantly different from *commitment*. Ginzberg (1981b) shows that two kinds of commitment are required for successful implementation:

- **Commitment to the Project Itself.** This means that during the stages of system development, installation and use, management ensures that everyone understands the problem is being designed to deal with. The system developed must solve the *right* problem; and
- **Commitment to Change.** This means that management and users are willing to accommodate the change that is likely to be required to implement the system or will be result of its introduction.

### 6.7.3 Institutionalisation

This is the process by which an IS becomes incorporated as an ongoing part of the organisational activities. It can occur in several ways: use of the system by successors to the original users, diffusion of the system to other users, change caused in the structure and processes in the organisation and a change initiated in the work of employees. As all these changes are expected to be permanent, institutionalisation clearly points to successful implementation (Turban, 1995).

### 6.7.4 User Computer Proficiency

The duration that a user has been using computers has been shown to be a critical factor contributing to satisfaction with a DSS. During the survey phase of this research, all the respondents interviewed were computer proficient.

In the research by Sanders and Courtney (1985), the findings showed that the longer people use a DSS, the more satisfied they became. This research, however, does not attempt to corroborate these findings.



## 6.8 User Involvement and Training

### 6.8.1 User Involvement

Hartwick and Barki (1994) suggest that the term refers to "a psychological state of the individual and is defined as the importance and personal relevance of a system to a user". From the literature, it is almost axiomatic that user involvement is a necessary condition for the successful development of an IS (see, for example, Ives and Olson, 1984). Ishman (1998) notes that a user's involvement and participation in the development and/or implementation of an IS have been validated as IS success variables. For a discussion of "better" user involvement in DSS and ES, see Despres and Rosenthal-Sabroux (1992).

There is agreement that user involvement is important. However, in determining when it should occur and how much attention is appropriate, are questions which receive inadequate research attention (Turban, 1995). In user-developed systems, the user is obviously very much involved but when teams are used, the involvement becomes fairly complex.

User involvement assumes a slightly different meaning with regards to DSS than with traditional computer applications. In the latter, users are frequently non management employees who are primarily involved in the planning, testing and evaluation stages. In the DSS environment, heavy user involvement is advocated *throughout* the developmental process without a considerable amount of direct management participation. Turban (1995) suggests that many researchers advocate not only user involvement but also user control of (and commitment to) the project, thus requiring continuous involvement and responsibility. As Keen (1980) and Naumann and Jenkins (1982) note, DSS applications tend to rely heavily upon an iterative development process which involves multiple executions of a combined analysis-design-implementation effort.

Fuerst and Martin (1984) report that user participation in model development ensures the opening and continuation of a communications channel which *should* lead to shared understanding (author's own italics). However, Mann and Watson (1984) found that new user involvement in DSS design can vary widely and that the amount of time required to reach a "shared understanding" is often too great and assumptions are made (Scholtz, 1996).

Figure 6.2 reflects the results of a study conducted by Hogue and Watson (1983) regarding management involvement in six phases of the DSS system development life cycle. The results reveal that there is substantial involvement in all phases of DSS development. Middle management involvement often differs from upper-management involvement in DSS development (Sprague and Watson, 1996). Turban (1995) suggests that the generally low levels of involvement by lower management can be explained by the fact that the systems studied were almost exclusively designed to support middle and/or top management decision-making.

**Figure 6.2 Management Involvement in the Development of DSS**

| | Management Level | | | |
|---|---|---|---|---|
| **Phase in Life Cycle** | **Lower** | **Middle** | **Top** | **All** |
| Idea (conceptualisaion) | 0% | 61% | 61% | 100% |
| Information requirements | 0 | 78 | 61 | 100 |
| Building | 11 | 72 | 6 | 78 |
| Demonstration | 11 | 78 | 28 | 89 |
| Acceptance | 0 | 72 | 67 | 100 |

(Source: Adapted from Hogue Watson, 1983)

Middle management takes the leadership role during the development process. This role is especially noteworthy during the physical building process as it is not limited to situations where the DSS is being developed for a middle management decision-making process but it rather extends into applications for upper management as well. Sprague and Watson (1996) report that it may be logically expected that more direct management involvement in system building results from employing more user-friendly development tools (*i.e.* DSS generator rather than DSS tools). Research by Hogue and Watson (1983) has shown a general tendency for DSS applications developed using a DSS generator, have been developed by end users of the system. Those developed from DSS tools are more likely to have been developed by IS.

### 6.8.2 User Training

The required training for building DSS can be very different (Turban, 1995). Training can be provided "in house", the software vendor or by a university (see, for example, Chrisman and Beccue, 1990).

Training required to use the DSS technology is usually fairly minimal but in some large-scale integrated systems the required training may be substantial (Turban, 1995). Training should not only describe the system and explain why it is being installed but it must also teach users how to ask for information and how to use the information they receive. As training is a continuous process, it must be conducted as new people enter the system. It should take place whenever significant changes are made to the system.

During the field study phase of this research, the existence of appropriate DSS training (*e.g.* properly conducted, timely, enough time allocated) was investigated. The findings are reported in section 9.3.3 and discussed in section 10.2.2.

## 6.9 Organisational Factors

Organisational factors may cause systems to fail (Turban, 1995). Some of the cited factors are:

- **Competence**. Parasuraman *et al* (1985) define *competence* as the "possession of the required skills/knowledge to perform the service". Meador *et al* (1984b) found that participants' skills, especially those for the DSS builder and the technical support, were critical for the success of DSS. However, the results regarding the *perceived* importance of these skills and the estimated skill level in the respondents' organisations, showed that there is a wide gap between what is believed to exist in organisations and what is perceived as important. These results suggest that adjustments in this area can be most beneficial;
- **Value and Ethics**. Management is responsible for considering the ethics and values involved in implementing a DSS project. Three points are important:

  - **Goals of the project**. The process of implementation is based on an attempt to achieve organisational or departmental goals. The development team should decide whether the ultimate goals desired are ethical and whether the goals are ethical to those people who are crucial to the implementation process;
  - **Implementation process**. The builders should ask whether the implementation process is ethical and legal; and

- **Possible impact on other systems**. Whilst the goals and processes may both be ethical, the impact of the implemented system on another system may not be;

- **Adequacy of Resources**. The success of any IS project is dependent on the degree to which organisational arrangements facilitate access to the required system and other resources. Turban (1995) suggest that success depends on factors such as availability of terminals and personal computers, quality of the LAN, accessibility to databases, and software licences. Other factors include support and Help facilities (*e.g.* availability of Help Desk), software maintenance (see Swanson, 1988) and availability of hardware; and
- **Other Organisational Factors**. Other organisational factors important in DSS implementation are the role of the project sponsor who initiated the project and the compatibility of the system with organisational and personal goals of the participants. For a discussion of the responsibility for the development of DSS, see, for example, Huff (1984).

## 6.10 Project-Related Factors

The majority of the factors discussed in the previous sections can be considered elements in the implementation climate. Climate consists of the general conditions surrounding any application implementation; that is, climate is independent of any project (Turban, 1995). Even though a favourable climate is helpful, it is not sufficient. Consequently each specific project must be evaluated on its own merits, such as its relative importance to the organisation and its members. It must also satisfy certain cost-benefit criteria. Evaluation of a project involves several dimensions and requires consideration of several factors. See, for example, Meredith (1981).

### 6.10.1 User Expectations

User expectations as to how a system will contribute to their performance and the resultant rewards can greatly affect which system is utilised. See Robey (1979).

Expectations about a system's value bear a relationship on how the need for a system is perceived (Turban, 1995). If users do not expect a system to enable them to do their jobs better and thereby increase organisational efficiency, then they are not likely to perceive a great need for the system. Likewise, if users do not expect that the job tasks supported by the system will assist them in achieving goals, they will be unlikely to use the system. Expectations can be affected by attitudes, experience and training.

### 6.10.2 Cost-Benefit Analysis

Any IS application can be viewed as an alternative investment. Accordingly, the application should not only show a payoff but also an advantage over other investment alternatives, including the option of "doing nothing". Since the mid-1980s, there have been increased pressures to justify IS (see, for example, Allen, 1987) including MSS. Effective implementation depends to a large extent on the ability to make such justifications.

Each MSS project requires an investment of resources that can be viewed as the cost of the system in exchange for some expected benefits. For example, "a DSS may be necessary to just stay competitive with other organisations" (Holsapple and Whinston, 1996). The viability of a project is determined by comparing the costs with the anticipated benefits This comparison is commonly referred to as a **cost-benefit analysis**.

In practice a cost-benefit analysis may become rather complicated. This is especially evident with the iterative nature of DSS which makes it difficult to predict costs and benefits as the systems are constantly changing. DSS by their very nature are associated with difficult decisions, managerial operations and "significant externalities" (Sauter, 1997). Very few organisations conduct a cost-benefit analysis of their DSS (see Hogue and Watson, 1985; and Money *et al*, 1988). Instead they use a value analysis that includes non-monetary benefits (Keen, 1981; and Turban, 1995). For the purposes of this research, these benefits are not explored.

## 6.11 Evaluation

The special characteristics of DSS, particularly the cyclic and evolutionary nature of its implementation and its impact on decision-making, necessitate a special approach to its evaluation (Turban, 1995). See Figure 6.3. This special approach must be distinct from the usual type of "post implementation audit" for IS. Evaluations in that category are cumulative in nature and the intent is only to assess the outcome. In many cases, these cumulative evaluations suffer from "being too little and too late" as they do not help the organisation by revealing what factors led to those outcomes and how (or why) they occurred.

**Figure 6.3 A Survey: The Success of DSS**

| |
|---|
| **In a survey conducted by Meador *et al* (1984a), respondents were asked to rate their agreement with several statements and indicate the "success of their DSS". These statements included:** |
| 1. The DSS fits in well with our planning methods<br>2. It fits in well with our reporting methods<br>3. It fits well with our thinking about problems<br>4. It has improved our way about thinking about problems<br>5. It fits in well with the "politics" of how decisions are made around here<br>6. Decisions reached with the aid of the DSS are usually implemented<br>7. The DSS has resulted in substantial time savings<br>8. It has been cost-effective<br>9. It has been valuable relative it its cost<br>10. It will continue to be useful to our organisation for a number of years<br>11. It has so far been a success |

(Source: Adapted from Turban, 1995)

DSS evaluation must be an integral part of the DSS development and implementation encompassing all phases of the DSS development process (Turban, 1995). The emphasis on decision support must be the focal point of DSS evaluation. See Guimaraes *et al* (1992).

## 6.12 Implementation Strategies

During the past 25 years there have been many suggestions of implementation strategies for management science and for IS. Many of the suggestions are generic and can be used as guidelines in implementing DSS. The purpose of this section is to summarise strategies that were developed specifically for DSS.

Turban (1995) reports that the implementation strategies of DSS can be divided into four major categories:

- divide the project into manageable pieces;
- keep the solution simple;
- develop a satisfactory support base; and
- meet user needs and institutionalise the system.

In general terms, each of these categories may seem obvious. A number of distinct strategies exist under each heading. As shown in Figure 6.4, each one of these strategies has a certain purpose and certain pitfalls. In this research no attempt has been made to identify which categories (if any) were adopted by organisations which have implemented DSS in KwaZulu-Natal.

**Figure 6.4 DSS Implementation Strategy**

| Implementation Strategy | Typical Situation or Purpose | Pitfalls Encountered |
|---|---|---|
| **Divide project into manageable pieces** | To minimise the risk of producing a massive system that does not work | |
| Use prototypes | Success of the effort hinges on relatively untested concepts. Test these concepts before committing to a full-fledged version | Reactions to the prototype system (in an experimental setting) may differ from reactions to a final system in day-to-day use |
| Use an evolutionary approach | Implementer attempts to shorten feedback loops between self and clients and between intentions and products | Requires users to live with continuing change, which some people find annoying |
| Develop a series of tools | To meet *ad hoc* analysis needs by providing databases and small models that can be created, modified and discarded | Limited applicability. Expense of maintaining infrequently used data |
| **Keep the solution simple** | To encourage use and to avoid scaring away users | Although generally beneficial, can lead to misrepresentation, misunderstanding, misuse |
| Be simple | Not an issue for inherently simple systems. For other systems or situations, it may be possible to choose between simple and complicated approaches | Some business problems are not inherently simple. Insisting on simple solutions may result in skirting the real issue |
| Hide complexity | The system is presented as a "black box" that answers questions using procedures not presented to the user. | Use of "black boxes" by nonexperts can lead to misuse of the results because of misunderstanding of the underlying models and assumptions |
| Avoid change | Given a choice of automating existing practice or developing new methods, choose the former | New systems may have little real impact. Not applicable to efforts purporting to foster change |

| Implementation Strategy | Typical Situation or Purpose | Pitfalls Encountered |
|---|---|---|
| **Developing a satisfactory support base** | One or more components of a user-manager support base is missing | Danger that one support-gaining strategy will be applied without adequate attention to others |
| Obtain user participation | The system effort was not initiated by users. The usage pattern is not obvious in advance | With multiple users, difficulty of getting everyone involved and incorporating everyone's interests. With sophisticated models, reduced feasibility of user participation in model formulation and interpretation |
| Obtain user commitment | The system, has been developed without user involvement. The system is to be imposed on users by management | It is difficult to obtain commitment without some kind of *quid pro quo* or demonstration that the system will help the user |
| Obtain management support | To obtain funding for the continuation of the project. To obtain management action in forcing people to comply with the system or use it | Management enthusiasm may not be shared by users, resulting in perfunctory use or disuse |
| Sell the system | Some potential users were not involved in system development and do not use it. System is not used to full potential by the organisation | Often unsuccessful unless real advantages can be demonstrated convincingly |
| **Meet user needs and insitutionalise the system** | A system is to have many individual users in an ongoing application | Since strategies under this heading are somewhat incompatible, emphasis on one may exclude another |
| Provide training | The system is not designed in close co-operation with *all* potential users | Frequently difficulties in estimating the type and intensity of training that is needed. Initial training programs often require substantial reformulation and elaboration |
| Provide ongoing assistance | The system is used by an intermediary rather than a decision maker. The system is used with the help of an intermediary who handles mechanical details | If the system is used by an intermediary, the decision maker may not understand the analysis in sufficient detail |
| Insist on mandatory use | The system is a medium for integration and co-ordination in planning. The system purports to facilitate work of individuals | Difference between genuine use and half-hearted submission of numbers for a plan. Difficulty in forcing people in a particular mould |
| Permit voluntary use | Avoid building resistance to a hard sell by allowing voluntary use | Generally ineffective unless the system meets a genuine felt need or appeals to an individual intellectually or otherwise |
| Rely on diffusion and exposure | It is hoped that enthusiasts will demonstrate the benefits of a system to their colleagues | Ineffective: perhaps as much an excuse for lack of positive action as it is a real strategy |
| Tailor systems to people's capabilities | People differ in their ability and/or propensity to use analytic techniques | Not clear how to do so. In practice, systems seem to be built to people's requirements, not their capabilities |

(Source: Adapted from Alter, 1980)

## 6.13 Summary

In this chapter, it was indicated that many MSS projects either fail or are not completed as successful implementation is determined by many factors. Implementation is an ongoing process and means introducing change.

The success of implementation can be partial and it is usually measured by several criteria. Technical success is related to the system's complexity, reliability and responsiveness; hardware and software compatibilities and the technical skills of the builders. It was shown that organisational climate and politics can be detrimental to the success of any IS application.

There are many dimensions to change and to its resistance. Overcoming this resistance is a complex process and many individuals may resist MSS for several reasons. During implementation, top management support, user involvement and training are crucial.

Discussion indicated that several organisational factors are important to successful implementation. A lack of adequate resources means failure. Cost-benefit analyses exist but assessing benefits for DSS may be very difficult as many of them are intangible. Finally, a summary of DSS implementation strategies was given.

# Chapter 7

## DSS IMPLEMENTATION FRAMEWORKS

### 7.1 Introduction

IS implementations has been a topic of interest to researchers for nearly three decades. See previous discussion in section 6.3.

According to Alavi and Joachimsthaler (1992) implementation remains a high priority research topic for the following two reasons:

- Both corporate investments in and reliance on IS have significantly grown over the past two decades. Such systems have been used for competitive advantage, establishing direct electronic links with customers and suppliers, enhancing organisational planning and decision-making and reducing costs of business operations and transaction processing. As IS become increasingly intertwined in the operations, products and strategies and infrastructure of organisations, it is critical that implementation be successful. However, despite the proliferation of computers, the implementation of these systems remains a complex issue (see, for example, Ginzberg, 1981b; Tait and Vessey, 1989; and Lucas *et al,* 1990); and
- Reviews of IS implementation research (see, for example, DeSanctis, 1984a; Dickson, 1981; Ives and Olson, 1984; and Vasarhelyi, 1973) have revealed that collectively, implementation studies have yielded conflicting (and somewhat confusing) findings. For example, while Swanson (1974) showed a positive relationship for the benefits of user involvement, Lucas (1975) showed a non significant relationship, Doll and Torkzadeh (1989) and Olson and Ives (1981) showed mixed results. These reviews highlight faulty research designs and an inconsistency of findings. Guimaraes *et al* (1992) suggests that further empirical tests are needed to provide more evidence and a better understanding of this

(user involvement) factor. The extent to which the existing body of research reflects substantial and cumulative development is therefore not entirely clear.

## 7.2 The Underbelly of IS Development

Implementation is the software underbelly of IS development (Keen and Scott Morton, 1978). Implementation phenomena have been one of the earliest and most active researched options in the IS field (see, for example, Alter, 1975; Ginzberg, 1975; Pickett, 1978; and Lucas, 1981). Much of the research on IS implementation has been focused on identifying factors conducive to success or failure, including user involvement (*e.g.* Baronas and Louis, 1988), management support (*e.g.* Lee, 1986; and Leitheiser and Wetherbe, 1986), end user's expectation and attitude (*e.g.* Ginzberg, 1981a; Maish, 1979; and Robey, 1979), politics (*e.g.* Markus, 1983), communication between developers and end users (*e.g.* DeBrabander and Tiers, 1984), task structure (*e.g.* Guimaraes *et al*, 1992; and Sanders and Courtney, 1985) and end users' training and experience (*e.g.* Fuerst and Cheney, 1982; and Nelson and Cheney, 1987). As a result of this research, a wealth of knowledge exists regarding those factors which are most likely to influence an IS's successful implementation (see Yoon *et al*, 1995).

During the past two decades, a number of researchers have been involved in studying factors that may affect the implementation of IS. As Liang (1986) reports, many factors have been identified and these are shown in Figure 7.1. A summary of these previously identified factors on the implementation of IS is given in Figure 7.2.

Liang (1986) notes, however, that little of this research has focused on studying the relative importance of factors, nor has a general framework for describing the process of DSS adoption been developed. He indicates that a lack of knowledge of the relative importance of factors makes it difficult to effectively allocate management resources to the *most critical factors* (own italics) whereas lack of a general model of DSS use makes it difficult to integrate the results of various research efforts. Subsequent to this published literature, DSS implementation models have been formulated and tested. These will be discussed shortly.

**Figure 7.1 Factors affecting DSS use**

| Factors | Researchers |
|---|---|
| Accuracy of output | Fuerst and Cheney, 1982 |
| Cognitive style | Bariff and Lusk, 1977; Benbasat, 1977; Benbasat and Taylor, 1978; Benbasat and Dexter, 1982; Birnberg *et al*, 1980; Blaylock and Rees, 1984; Davis and Elnicki, 1984; Henderson and Nutt, 1980; Huber, 1983; Keen and Bronsema, 1981; Klempa, 1984; Lusk, 1979; McGhee *et al*, 1978; Motiwalla and Pheny, 1982; Pratt, 1980; Robey, 1983; Sussman and Belohlaw, 1981; Taylor and Benbasat, 1980; Waele, 1978; and Zmud, 1979 |
| Environmental stress | Benbasat and Taylor, 1982; DeBrabander and Thiers, 1984; Motiwalla and Pheny, 1982; and Schroeder and Benbasat, 1975 |
| Human biases | Benbasat and Taylor, 1982; and Remus, 1980 |
| Implementation strategy | Alavi and Henderson, 1981; and King and Rodriguez, 1981 |
| Information transfer specialist | Welsh, 1981 |
| Information complexity | Benbasat and Taylor, 1982; and Watkins, 1979 |
| Job complexity | Lusk and Kersnick, 1979; Motiwalla and Pheny, 1982; and Streufert and Schroder, 1965 |
| Length of DSS use | Sanders and Courtney, 1985 |
| Management support and attitude | Hethlie, 1983; Lucas, 1978; Sanders and Courtney, 1985; Schewe, 1976; and Mehra, 1979 |
| Motivation | DeSanctis, 1982 |
| Power, politics and other organisational variables | Hethlie, 1983, Markus, 1983; Roland, 1980; Sage, 1981; and Sanders and Courtney, 1985 |
| Representation format | Bell, 1984; DeSanctis, 1984b; Ghani, 1981; Jacob and Sprague, 1980; Lucas and Nielson, 1980; Lusk *et al*, 1979; Remus, 1980; and Remus, 1984 |
| Response time | Barber and Lucas, 1983; Goodman and Spence, 1978; Goodman and Spence, 1981; and Miller, 1968 |
| User attitude | Adams, 1975; Kaiser and Srinivasan, 1980; Lucas, 1975; Maish, 1979; Robey, 1979; and Toubkin and Simis, 1980 |
| User expectation | Ginzberg, 1981b; and Toubkin and Simis, 1980 |
| User involvement | Ives and Olson, 1980; 1984; Keen, 1980; King and Rodriguez, 1981; DeBrabander and Edstrom, 1977; Robey and Farrow, 1979; and Swanson, 1974 |
| User training and experience | Fuerst and Cheney, 1982; and Sanders and Courtney, 1985 |
| User-specialist communication | DeBrabander and Tiers, 1984 |

(Source: Adapted from Liang, 1986)

**Figure 7.2 Classification of Factors**

| DSS | User | Task | Environment |
|---|---|---|---|
| Quality of system<br>o accuracy of model<br>o representation format<br>o response time | Cognitive style | Information complexity | Environmental stress |
| Implementation strategy<br>o User involvement<br>o Evolutionary design | Human bias | Job complexity | Information transfer specialist |
| | Motivation | | Management support and attitude |
| | User attitude | | Power, politics and other considerations |
| | User training | | |
| | Background and experience | | |
| | Background and experience<br>o Length of DSS use<br>o Experience with IS | | |

(Source: Adapted from Liang, 1986)

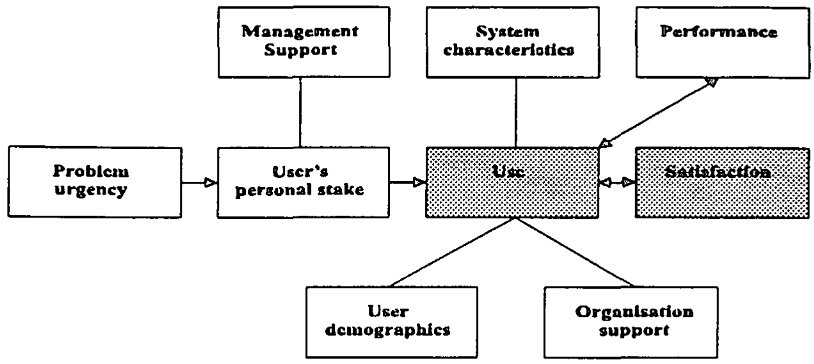
## 7.3 Frameworks

Frameworks are descriptive structures of DSS implementation. There are *several* frameworks for DSS that classify the relationships that are relevant to DSS implementation (Turban, 1996). They are all related to the generic information system framework as reflected in Figure 7.3. Some of the representative frameworks (or models) are:

### 7.3.1 The Lucas, Ginzberg and Schultz Model

This generic IS implementation model which was developed and tested, is shown in Figure 7.3. It suggests that the user's personal stake in the problems are an important determination of use. Personal stake refers to how important the domain of the system is for the individual and is hypothesized to be influenced by the level of management support for a system (Turban, 1996). Implementation research has indicated the importance of *management support and leadership* in successful implementation. Problem urgency (*i.e.* the more urgent the problem, the higher the personal stake) also influences the personal stake.

**Figure 7.3 An implementation model**




(Source: Lucas, 1981)

Turban (1996) expects personal stake to influence DSS usage "so long as use is voluntary". He indicates that system characteristics will also influence use as a poorly designed system may be virtually unusable. User demographics (*i.e.* age and previous computer experience) are also likely to impact system usage. Organisational support refers to actions which facilitate easy use of a system and the model suggests that high levels of use should lead to high levels of satisfaction (and vice versa). This high level of satisfaction, may lead to increase levels of use.

7.3.2 <u>The Guimaraes, Igbaria and Lu Model</u>

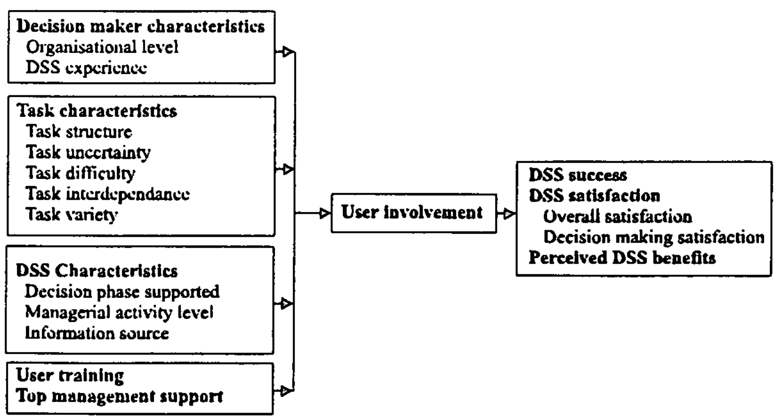
The Guimaraes, Igbaria and Lu model (hereinafter referred to as the Guimaraes-model for brevity) represents the *first* development and test of an integrated model for the determinants of DSS success (Guimaraes *et al*, 1992). This comprehensive DSS implementation model is partially based on the Lucas *et al* (1991) model. Figure 7.4 represents the Guimaraes-model of DSS success as formulated and tested by Guimaraes, Igbaria and Lu in their research.

The Guimaraes-model examined by the researchers' study, comprised six sets of variables:

- characteristics of the implementation process (top management support, user training and user involvement);

- characteristics of the business task (task structure, task difficulty, task variability and task independence);
- characteristics of the decision makers (organisational level and DSS experience);
- characteristics of the DSS (the supported base, level of managerial activity and source of information);
- user satisfaction with the DSS; and
- user perceptions of DSS benefits.

**Figure 7.4 Integrated model of the determinants of DSS success**




(Source: Guimaraes, Igbaria and Lu, 1992)

Guimaraes *et al* (1992) report from their data analyses that DSS success, as measured by DSS satisfaction and perceived benefits, depends on several factors:

- previous user experience with DSS;
- user involvement;
- user training;
- top management support;
- information source;
- the level of managerial activity being supported; and
- task structure, difficulty and interdependence. Turban (1996) refers to this factor as "the characteristics of the task involved".

The researchers state that many of the relationships proposed through the model and the specific hypotheses have been supported empirically. Furthermore the results have provided the basis for recommendations to improve DSS development and implementation in practice.

Guimaraes *et al* (1992) are of the opinion that their study's contributions are significant. They note that it has some obvious limitations which should be addressed by further research. One of these limitations is that "other variables may be added to the model as possible determinants of DSS success". From the literature survey, the author has identified another published DSS implementation model (by researchers Kivijärvi and Zmud). The Kivijärvi and Zmud DSS model will be discussed in section 7.4.

### 7.3.3 Group DSS

Pinsonneault and Kraemer (1989) proposed a comprehensive framework for GDSS. Grohowski *et al* (1990) developed a list of success indicators based on a laboratory study. These GDSS success factors have been organised into groups. See Buckley and Yen (1990). An extensive list of success factors for GDSS is also suggested by Turban (1995). GDSS do not form part of this research.

### 7.3.4 EIS

Turban (1996) states that the implementation of EIS may be more difficult than that of a regular DSS due to:

- the infrastructure nature of the system;
- the need for substantial investments;
- it is not an end-user constructed project; and
- it may pose a threat to people because of the tight monitoring and control it provides to management.

Rockart and DeLong (1988) proposed the first set of EIS success factors which included a committed and informed executive sponsor, an operating sponsor, a clear link to business objectives, appropriate IS resources, appropriate EIS technology, management of data problems, management of organisational resistance and management of spread and system evolution. For a discussion of these success factors in the South African environment, see Steer (1995) and Chilwane (1996).

7.3.5 Cognitive Framework

Much of previous implementation research is behaviourally-oriented as many of the researchers are of the opinion that the behavioural factors are most important for successful implementation. Griffith and Northcraft (1996) developed a generic cognitive framework for the implementation of any new technology and they examined the interactions among system developers, users and implementers. The researchers specifically investigated differences in cognitions (thought, perceptions and constructed understanding) as they related to successful implementation.

From these five presented models, Turban (1996) states that they "**provide a basis for conducting research**". He also indicates that the results of the research may or may not be used in assisting organisations "**to improve the chances of successful DSS implementation**". Finally, he notes that "**practitioners consider the issue of implementation not from what is interesting to the researchers, but rather from a practical point of view**"(all bold lettering added by author). This forms the basis for this research.

From the models discussed in sections 7.3.1 - 7.3.5, Turban formulates a "practical DSS model". He identifies the major factors that have an impact on implication and it includes some of the variables which are included in the research models. For a further discussion of the model, see Turban (1996). The major independent variables in each category of the "practical model" are reflected in Figure 7.5.

**Figure 7.5 The Determinants of Implementation**

| Category | Variables |
|---|---|
| Technical factors | The degree of complexity of the DSS<br>DSS response times<br>DSS functions<br>System reliability |
| Behavioural factors | Decision Style<br>Organisational climate<br>Organizational expectations<br>Resistance to change |
| Process factors | Top Management Support<br>Management and users' commitment<br>Experience in using DSS |
| User Involvement and Training | Degree of participation<br>Empowerment<br>Training |
| Organisational Factors | Competence of the DSS builder<br>The relationship between users and the IS department<br>Organisational politics<br>Values and ethics in the organisation |
| Specific project DSS related | The urgency and importance of the project<br>The adequacy of resources devoted to the DSS<br>Level of expectations<br>Cost/benefit ratio<br>Project Management<br>Availability of an accessibility to data |
| External environment | Vendors, customers<br>Government regulations<br>Interorganisational relationships (DSS relevant) |

(Source: Adapted from Turban, 1996)

## 7.4 A DSS Research model developed by Kivijärvi and Zmud

A research model developed by Kivijärvi and Zmud (1993) integrates variables representing three main constructs plus control variables:

### 7.4.1 DSS implementation activities

The one component of the model is the phasic nature of DSS implementation *e.g.* those activities (which occur sequentially, in parallel or iteratively) which comprise the entire DSS implementation process *i.e.* the design, development, use and subsequent evolution of DSS. Their view of DSS implementation evolved from the phasic structures associated with organisational change processes (Lewin, 1952; and Schein, 1961), with the adoption of technological innovations (Peirce and Delbecq, 1977; Schultz and Slevin, 1977; and Zaltman *et al*, 1977), with decision-making (Mintzberg *et al*, 1976; and Nutt, 1984), with IS development (Zmud, 1983; and Lucas, 1985) and with DSS development (Sprague and Carlson, 1982; Meador *et al*, 1984b; and Meador *et al*, 1986). By synthesising these literatures, a preliminary set of operational DSS implementation activities was evaluated in a pilot study and a set of activities being developed. However, this set is not discussed any further.

### 7.4.2 DSS Success

Kivijärvi and Zmud (1993) acknowledge that defining and measuring the success of an IS has been the most difficult issue with which implementation has contended. They note that a number of different measurement approaches have been used with prior DSS research, reflecting both individual and organisational as well as both economic and personal outcomes (Sprague and Carlson, 1982; Sanders, 1984; Welsch, 1986; and Galletta and Lederer, 1989).

The ultimate purpose of most DSS is to improve decision making *effectiveness*. See previous discussion in section 3.4 and Udo (1992). This is underscored by Kivijärvi and Zmud (1993) but contend that this suggests that DSS are likely to have two kinds of effects: direct and indirect. Direct effects (*e.g.* decision support) are felt as the DSS is used and indirect effects (decision effectiveness) are only felt after the decision actions have been taken. Such notions have led the researchers to the conceptualisation of DSS success as reflected in Figure 7.6.

For a detailed discussion on each of these four measures of success, see Kivijärvi and Zmud (1993). These four measures of success will be integrated with the success measures from the Guimaraes-model and discussed in section 7.5.

**Figure 7.6 DSS success Measures**

| Dimensions | Individual | Organisational |
|---|---|---|
| Indirect | User information satisfaction | Perceived utility |
| Direct | Relative Use | Goal realisation |

(Source: Adapted from Kivijärvi and Zmud, 1993)

### 7.4.3 Problem Domain characteristics

The researchers identified three important attributes of the problem domain: the nature of available knowledge regarding the set of alternatives to be taken, the degree of complexity inherent in the elements of a problem and between them and the criticality of the problem (*i.e.* its importance and urgency).

### 7.4.4 Control variables

Kivijärvi and Zmud (1993) state that variables other than the nature of DSS implementation activities and problem domain attributes also affect DSS implementation success. The researchers have selected three constructs that have been shown to be related to the success of DSS by prior implementation research. These are: user participation, organisational size and the maturity of the organisation's portfolio of IS.

## 7.5 The Guimaraes- and Kivijärvi and Zmud models

The works of Guimaraes *et al* (1992) and Kivijärvi and Zmud (1993) suggest various conditions are critical to the implementation of DSS. The author has combined the conditions suggested by these researchers as being critical to the successful implementation of DSS. The associated evidence items were extracted from the available literature (see, for example, Sanders,1984; Baroudi and Orlikowski, 1988; and Goodhue, 1990).

A questionnaire was developed to establish whether evidence exists in each surveyed organisation and for each specific CSF (see Appendix E and Averweg, 1998).

## 7.6 Efraim Turban's Recent Research

To stay abreast of ongoing advances in the decision support system field, Holsapple and Whinston (1996) advocate that is helpful to monitor a variety of periodicals that publish articles with DSS issues and the proceedings of conferences concerned with DSS research. Following Turban's (1996) research, he indicates that the following are the major conclusions of a survey regarding DSS implementation:

### 7.6.1 Success: Development and Use

It is necessary to distinguish between success in *system development* and success in *system operation* (use);

### 7.6.2 Segmentation of the Problem

Due to the complexity of the topic, it is better to concentrate on a segment of the problem rather than on the entire field. Segmentation can be done by DSS technology (*e.g.*, DSS, GDSS, EIS) by a category of factors (technical, behavioural, process) or by the players (users, builders);

### 7.6.3 Comparative International Studies

There is a need for more empirical research, especially for comparative international studies;

### 7.6.4 Practical Approach

There is a need for more practical approach to the investigation;

### 7.6.5 Research Closer to Reality

There is a need to bring some of the behaviourally-oriented research closer to reality. That is, some of the researchers' interests are in the ivory tower. The researchers tend to speak to themselves;

7.6.6 Quantification of successful DSS

More research should be directed towards the quantification of "successful DSS implementation". Unless there is a better definition and measurement of the success factor it will be difficult to develop good research and meaningful implementation strategies; and

7.6.7 Implementation Scenarios

Since there are many determinants of successful implementation it is difficult to build implementation strategy. However, this is exactly what the practitioners desire. One solution is to develop implementation scenarios and prescribe strategy for standard scenarios.

The above conclusions serve as a platform to this research. Accordingly, the following framework will be used:

7.6.8 Success: Development and Use

This research focused on **system operation** (use);

7.6.9 Segmentation of the Problem

As suggested by Turban (1996) that it is better to focus on a segment of the problem, this stance is adopted. Accordingly, the research will be geared towards DSS and the **users**;

7.6.10 Comparative International Studies

This DSS research specifically embraces a comparative study of CSFs in existence internationally and those surveyed in KwaZulu-Natal organisations which have implemented DSS;

7.6.11 Practical Approach

With regards to the practical approach to the investigation, a field study approach will be adopted. However, it is important to view this in the context of other approaches. Consequently the different empirical research approaches which exist will be discussed later in section 8.2;

7.6.12 Research Closer to Reality

By adopting the field study approach, the research is directed at the world of reality. This avoids the problems with external validity normally found within controlled laboratory settings (Garrity, 1994). Furthermore it is envisaged that the findings and conclusions reached will have immediate, practical and real-world application which will circumvent any perceived "ivory tower" syndrome;

7.6.13 Quantification of successful DSS

In this research an attempt will be made to identify the CSFs for the successful implementation of DSS in organisations in the KwaZulu-Natal environment. This will augment Turban's (1990) stance regarding the quantification of "successful DSS implementation" but it should be noted that no attempt will be made regarding the measurement of these CSFs. This may be an avenue for further research; and

7.6.14 Implementation Scenarios

Even though Turban (1996) advocates one solution to develop implementation scenarios and prescribe strategy for standard scenarios, it is felt that in the circumstances a contingency approach best serves this purpose. Furthermore, with the possible differing interpretations of the term "standard scenarios", this contingency approach is considered more appropriate.

## 7.7 Summary

In this chapter it was shown that IS implementations have been a topic to researchers for nearly three decades. Implementations are the software underbelly of IS development.

From the literature, two tested frameworks for the implementation of DSS were identified and discussed. The CSFs from the Guimaraes, Igbaria and Lu model (user involvement, user training, top management support, information source, the level of managerial activity being supported, and task structure, difficulty and interdependence) and Kivijärvi and Zmud model (user information satisfaction, perceived utility, relative use, and goal realisation) were combined. From the available literature, the associated evidence items for each CSF were identified.

With a recent suggestion by eminent DSS researcher Efraim Turban for DSS research to be more practically oriented, this approach has created a fertile climate for the identified CSFs for DSS implementation to be investigated in the KwaZulu-Natal environment.

The author's selected methodology for undertaking this research will be described in the next chapter. Thereafter in Chapter 9, the results of the findings are discussed and recommendations for the implementation of DSS in organisations in KwaZulu-Natal are made.

# Chapter 8

## THE RESEARCH METHODOLOGY

### 8.1 Introduction

The goals of this research were identified in section 1.4. In summary it is to identify those CSFs which have been previously extracted by researchers and establish whether they are in existence in organisations in KwaZulu-Natal which have implemented DSS, then identify the CSFs associated with DSS implementations and from the results obtained, make recommendations regarding future DSS implementations in KwaZulu-Natal organisations.

In sections 1.8 and 1.9, a brief overview of the research method and the importance of this research were described. In this chapter previously identified research approaches are discussed and the methodology chosen for this research is described.

### 8.2 Methodologies for Research Areas and Issues

Kraemer (1991) suggests that there are five major methods used in the field of IS research. These are qualitative research, experimental research, survey research, mathematical models and software systems demonstrations.

Since MSS (see section 2.1) deal with organisations and individuals using computers to improve decision-making, Benbasat (1985) states that it is not surprising to find all methodologies being used to study the wide range of research issues in the field. The researcher has attempted to identify the research methodologies appropriate for conducting research in MSS by surveying the studies directly or indirectly related to the field. From the results and findings, he recommends methodologies to be used for particular research areas and issues. For implementation research areas, these are summarised in Figure 8.1. Attention is drawn to the fact that Benbasat (1985) "highly recommends" *field studies* for the change process dynamics in the implementation research area.

**Figure 8.1 Research Areas and Recommended Research Strategies**

| Research Area | Research Focus | Case Studies | Field Studies | Laboratory Experiments |
|---|---|---|---|---|
| Implementation | Dynamics of Change Process | Recommended | Highly Recommended | Recommended |
| | Organisation; Various Phases of Project Life; Multiple Participants | Recommended | Recommended | |
| | Single User; Individual Differences | | | Recommended |

(Source: Adapted from Benbasat, 1985)

The researcher reports that field studies are useful for two purposes:

- to test the value of different interface features by tracking actual use and collecting statistics on efficiency measures; and
- to test the power of organisational change models to explain the implementation process and *predict its success* (author's own italics).

Following the work by Van Horn (1973), Van Schaik (1988) distinguishes four approaches:

- **Case Study**. This is an investigation of a single organisation with respect to a number of variables. He contends that case studies do not provide experimental design or control as the observer simply records what exists. This is an approach followed by Thierauf (1982);
- **Field Study**. An investigation of several organisations with respect to one or more variables with an experimental design but without experimental control is made. Examples are Koeleman (1988); and Molengraaf (1988) who interviewed users of DSS at eight companies working with one brand of DSS generator and eight companies working with another brand of DSS. The researchers then compared the findings. Other examples are Sanders and Courtney (1985); and Mc Leod and Jones (1986);

- **Field Test**. An investigation of one or more organisations with respect to one or more variables with a specific experimental design and with experimental control is made. Sprague (1971) describes this approach; and
- **Laboratory study**. An investigation is made of aspects of IS within a simulated environment. Research following this approach is described by Dickson *et al* (1977) and Orlikowski and Baroudi (1991).

After an in depth analysis of many empirical research projects which used these four methods, Van Schaik (1988) reports that Van Horn (1973) drew the following conclusions:

- **Case studies** provide little insight into the key research issues of IS. This may be partially attributed to the complexity of the research problems and to the lack of careful chronology and detail. Furthermore, McLean (1973) levels the criticism of who knows whether the research outcome can extend beyond a single organisation which has been studied;
- **Field studies**, which are attempts by researchers to gather data in ongoing uncontrolled situations, are inefficient primarily due to the large amounts of data that have to be collected. This stance is not supported in more recent literature by Sprague and Watson (1996) as these researchers state that one approach which has recommended *specifically* (author's own italics) for the evaluation of DSS success considers elements which are measurable and common sense. Another problem which is cited is the lack of experimental control to isolate the key independent variables. From the recent literature survey, no supporting evidence can be found;
- **Field tests** which attempt to introduce change and measure some aspect of the system are plagued by the subordinate role a controlled study is forced to play to the necessary operations and survival of the organisation. According to Van Horn (1973) field tests described in the literature are extremely rare and "the ones that are published are sad stories". He indicates that the competing demands of careful experimental control and the pressing concerns of the organisation

inevitably yield to the latter and that almost all field tests end up as case or field studies; and

- **Laboratory studies** attempt to control and measure phenomena through the creation of a model of the system and offer the only viable approach for many aspects of research into MIS.

The author recognises that the laboratory approach may have advantages (*e.g.* for the measurement and control of variables). Since Turban (1996) advocates a "more practical approach" to the investigation and as there are no documented field studies on CSFs for DSS implementations in the South African environment, this approach has been adopted.

## 8.3 Description of Research Methodology

The passive observation research process is the most commonly used approach in the study of IS (Remenyi and Williams, 1995) and was used for this research. Passive observation occurs when the researcher draws on conclusions from information collected during interviews, from reports and by administering questionnaires. Passive observation follows the steps shown in Figure 8.2.

**Figure 8.2 Steps in Passive Observation Research Process**

1. Literature Review
2. Assessment of the Established Theory
3. Theoretical Conjecture
4. Hypothesis or Empirical Generalisation
5. Data Collection Strategy
6. Measuring Instrument
7. Sampling
8. Testing and Analysis
9. Confirmation of Theoretical Conjecture and development of Fuller and Refined Theory

(Source: Adapted from Remenyi and Williams, 1995)

### 8.3.1 Literature Review

As Remenyi and Williams (1995) report, it is important for a researcher to evaluate the available literature on the subject being researched as it allows the researcher to review the current theories and models that have been made by other researchers in the field and to identify unsolved problems. Melville and Goddard (1996) state that a research problem should be well understood and a full demarcation of the research problem is also necessary. This was achieved in section 1.3.1.

During an extensive study by the author of the available literature on DSS implementations, it was apparent that there was no evidence that an attempt has been made to research CSFs for DSS implementations in South African organisations. See section 1.10. Excluding technical aspects of DSS implementations, there is little literature available to help KwaZulu-Natal organisations identify the critical areas that contribute to the success of DSS implementations. This suggests that KwaZulu-Natal organisations would benefit from a set of guidelines to assist them in implementing DSS. This approach supports the work of Bester and Olivier (1992) in that the statement of the problem should allow for the possibility of the result(s) of the research being useful.

### 8.3.2 Assessment of the Established Theory

Remenyi and Williams (1995) state that it is important to decide early on if the identified problem in the literature is sufficiently explicit and generally accepted by people working in the field as a relevant problem for the researcher to be able to develop a theoretical framework and to derive a workable and testable hypothesis.

A number of researchers have been involved in studying factors that affect the implementation of IS and several models of implementation been proposed for IS (see, for example, Lucas, 1981; Meredith, 1981; and Swanson, 1988). However, Turban (1996) reports that there are "fewer models specifically designed for DSS". As Liang (1986) contends, many DSS have been developed and implemented but the "successful implementation of a DSS, however, is not a trivial issue". A number of factors may play roles in the DSS implementation process and the risk of failure is high unless the process is well managed (Liang, 1986). In order to reduce the risk of failure, the researcher suggests a detailed understanding of the issue and poses the explicit question: "What are the factors affecting successful DSS implementation?".

A detailed discussion of the various implementation issues was undertaken in Chapters 6 and 7. Coupling this with Turban's (1996) stance that the results of DSS implementation research may be used in assisting organisations "to improve the chances of successful DSS implementation", this indicates that the author's problem statement (see section 1.3.1) is sufficiently explicit and is generally accepted in the field as a *relevant* problem.

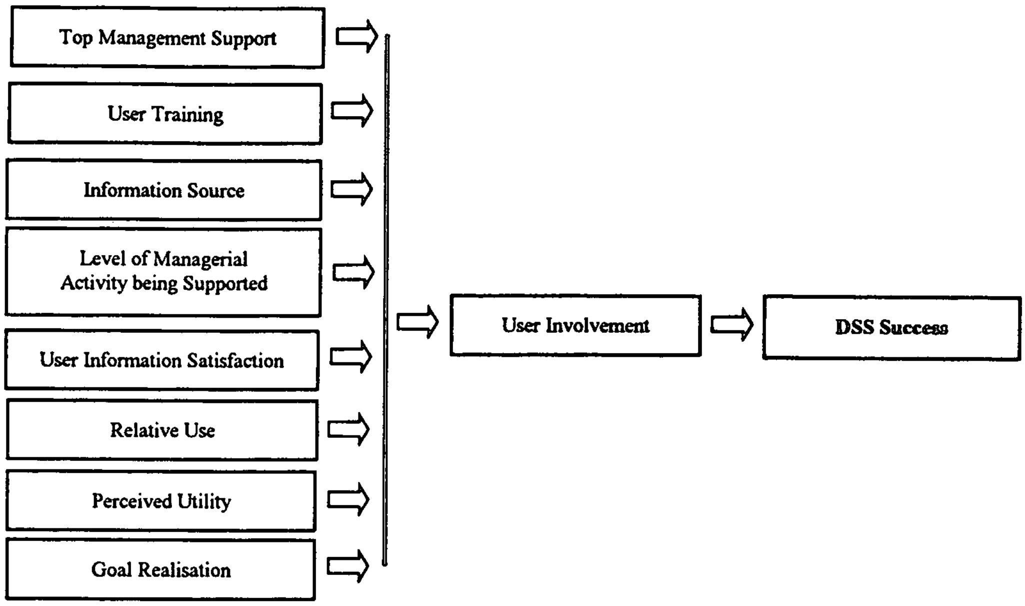
### 8.3.3 Theoretical Conjecture

From the information gathered during the literature review on the variables or factors that are thought to be associated with successful DSS implementation, and the author's work in KwaZulu-Natal organisations utilising DSS to assist its managers in approaching ill-defined problems and assist in decision-making, a theoretical conjecture was made. The starting point of this research was to extract the CSFs for the successful implementation of DSS from the literature. The theoretical conjecture was:

> **The CSFs for the successful implementation of DSS in organisations in KwaZulu-Natal are evidenced by the integration of the Guimaraes, Igbaria and Lu model (Guimaraes *et al*, 1992) and Kivijärvi and Zmud model (Kivijärvi and Zmud, 1993) for DSS implementation.**

The integrated model is shown in Figure 8.3. It supplies a suitable framework for the investigation of CSFs for the implementation of DSS in organisations in KwaZulu-Natal.

**Figure 8.3 Integrated Guimaraes, Igbaria and Lu model and Kivijärvi and Zmud model**




### 8.3.4 Hypothesis or Empirical Generalisation

Steer (1995) reports that in order to test a new theory, it must be stated as a set of clearly defined empirical generalisations. The empirical generalisation for this research is:

> **The nine CSFs for the successful implementation of DSS in organisations in KwaZulu-Natal are:**
>
> - **User Involvement;**
> - **Top Management Support;**
> - **User Training;**
> - **Information Source;**
> - **Level of Managerial Activity being Supported;**
> - **User Information Satisfaction;**
> - **Relative Use;**
> - **Perceived Utility; and**
> - **Goal Realisation.**

Based on the responses to the questionnaire instrument used in this research, the author reports (see section 9.2.1) that all the nine above stated CSFs are found in surveyed organisations in KwaZulu-Natal which have successfully implemented DSS. For surveyed organisations in which only some of the nine CSFs are found, these organisations are either partially successful or not successful with their DSS implementations.

### 8.3.5 Data Collection Strategy

In the social sciences, the collection of data for the purposes of testing a theory may be carried out in many ways (Remenyi and Williams, 1995). Different approaches include case studies, structured or semi-structured interviews, participant-observer studies and questionnaires.

Structured or semi-structured interviews allow detailed evidence to be elicited from individual respondents. They are encouraged to raise and suggest issues and problems which they regard as important to the issue being researched. They "allow complex and rich evidence to be gathered" (Remenyi and Williams, 1995).

Melville and Goddard (1996) indicate that one has to measure data somehow. Any device used for this measurement is called an instrument.

### 8.3.6 Measuring Instrument

Kothari (1993) states that in social science studies, when measuring attitudes of people, researchers generally follow the technique of preparing an opinionnaire (or attitude scale). He defines an opinionnaire (more commonly referred to as a questionnaire in South Africa) as "an information form that attempts to measure the attitude or belief of an individual". Cooper and Emory (1995) indicate that the measuring instrument should be easy and efficient to use. The important criteria for instruments are validity, reliability and practicality. Different scales for measuring attitudes of people are given by Kothari (1993). See Figure 8.4.

**Figure 8.4 Different Scales for Measuring Attitudes of People**

| | Name of the Scale Construction Approach | Name of the Scale Developed |
|---|---|---|
| 1 | Arbitrary Approach | Arbitrary Scales |
| 2 | Consensus Scale Approach | Differential Scales (such as Thurstone Differential Scale) |
| 3 | Item Analysis Approach | Summated Scales (such as Likert Scale) |
| 4 | Cumulative Scale Approach | Cumulative Scales (such as Guttman's Scalogram) |
| 5 | Factor Analysis Approach | Factor Scales (such as Osgood's Semantic Differential, Multi-dimensional Scaling) |

(Source: Adapted from Kothari, 1993)

From Figure 8.4 and in reviewing the literature on DSS research, only references to Likert-type scales were found.

Kothari (1993) suggests that even though there are some limitations with all scales, Likert-type scales are regarded as the most popular in social studies relating to measuring of attitudes. For example, Likert-type scales are relatively easy to construct in comparison to Thurstone-type scales because Likert-type scales can be performed without a panel of judges. Furthermore it is considered more reliable because under it respondents answer each statement included in the instrument and as such it also provides more information and data than does the Thurstone-scale. However, Kothari (1993) notes that there are several limitations of the Likert-type scale. For example, one important limitation is that whilst one can simply examine whether respondents are more or less favourable to a topic, one cannot tell how much more or less they are. Even with these recognised limitations, there is wide usage of Likert-type scales (see, for example, Franz and Robey, 1986; Doll and Torkzadeh, 1988; Sanders, 1984; Davis, 1989; Goodhue, 1990; and Lai, 1996).

Once the area of research had been identified, it would be necessary to administer the measuring instrument. However, during the construction of the questionnaire it became apparent that due to the "soft" nature of the research topic, it would be difficult to extract the true feelings and opinions from respondents through a structured, self completion post-back questionnaire. Steer (1995) cited similar difficulties. As it was realised that some of the research findings would be based on the subjective opinions of the respondents, it was decided that instead of performing a questionnaire survey, a number of in-depth interviews would be undertaken.

## 8.4 Conduct of the Survey

The questionnaire was validated using expert opinion. Particular attention was given to Straub's (1989) guideline involving the use of a pretest for the technical validation of the research instrument. This validation included the use of "previously validated instruments wherever possible" (Straub, 1989).

As a preamble to the interview, the classification of the various types of IS and the distinguishing characteristics of DSS was discussed with each interviewee. A working definition of a DSS was also given. See Appendix D. This preamble to the actual interview meant that the interviewee was properly focused on the DSS information systems in the organisation. The questionnaire instrument (see Appendix E) consisted of three parts:

- Part One dealt with the organisation's demographics and the attributes of the organisation's DSS;
- Part Two consisted of 28 evidence item statements each on a 5-point Likert scale. As indicated in section 7.5, these evidence items were drawn from established instruments to facilitate validation. The associated evidence items for each CSF are shown in Figure 8.5.

  The use of Likert scales is common in DSS research. For example, Davis (1989) in his DSS research, used Likert scales to measure perceived usefulness and attributes of perceived ease of use. Lai (1996) used Likert scales for his IT sophistication and DSS usage questions. This Likert-scale approach was adopted by the author; and

Figure 8.5 CSFs and associated Evidence Items

| CSF | Associated Evidence Item Statement numbers |
|---|---|
| User Involvement | 1, 5, 17 |
| Top Management Support | 2, 3, 11 |
| User Training | 4, 6, 7 |
| Information Source | 8, 9, 10, 23 |
| Level of Managerial Activity Being Supported | 13, 14, 15 |
| User Information Satisfaction | 16, 19, 20 |
| Relative Use | 18, 21, 22 |
| Perceived Utility | 24, 25, 26 |
| Goal realisation | 12, 27, 28 |

- Part Three contained open-ended questions regarding factors expected to be significantly important to DSS implementation. All these factors were from the integrated Guimaraes, Igbaria and Lu model and Kivijärvi and Zmud model (see Figure 8.3).

8.4.1 Pilot Study

A pilot study was conducted to ensure that the interview schedule was clear, intelligible and unambiguous. In order to evaluate the initial questionnaire design, two DSS User Managers and an academic participated in a separate field test. Their comments led to a refinement of the questionnaire instrument. Their contributions are gratefully acknowledged.

8.4.2 Semi-Structured Interviews

An extensive interview schedule was compiled which was used for the semi-structured interviews. The interviews were conducted during the period October 1997 to June 1998.

In order to ensure that the interviewee replied specifically relating to DSS, the author identified DSS as having the following characteristics:

- applications which address long-range strategic planning and complex integrated problem areas;
- focus on decisions, flexibility and user friendliness;
- DBMS (see section 4.2.1) has interactive access and factual knowledge;
- decision capabilities dealing with semi-structured problems, integrated management science models and a blend of judgment and modelling;
- manipulation of numerical data is feasible;
- information supports specific decisions;
- analysts and managers are the lowest organisational level served; and
- emphasis is on effectiveness.

The interviews were conducted at the organisation's premises. The average duration of interviews was approximately 35 minutes.

### 8.4.3 Sampling

It is often not practical or possible to study an entire population (Melville and Goddard, 1996). Remenyi and Williams (1995) concur by stating that it is "nearly always impossible" to test the theory against all members of the target population. It is necessary to select a sample which is both representative and unbiased of the overall population on which to conduct the test.

The sample selected was planned to include organisations with actual DSS experiences, including representatives of the following three sectors:

- business managers/users whose organisations utilise DSS;
- professional consultants in the DSS arena; and
- IS department members whose organisations have implemented DSS.

The sample was selected using the unbiased "snowball" sampling technique. Cooper and Emory (1995) state that this technique has found a niche in recent years in applications where respondents are difficult to identify and are best located through referral networks. During the initial stage of snowballing, individuals are "discovered" and may or may not be selected through probability methods. This group is then used to locate others who possess similar characteristics and who, in turn, identify others. In this way a researcher collects evidence from a group of qualified respondents (Remenyi and Williams, 1995). Steer (1995) indicates that the snowball sampling technique is a widely accepted business approach in business research.

The organisations considered for interview were chosen over a spread of industries (*e.g.* banking, retail, manufacturing, local authority). Using the snowball sampling technique, the author targeted 27 sizeable and well-established organisations in KwaZulu-Natal which have DSS experience. Where an organisation had implemented more than one DSS, the most recent DSS implementation was selected. The classification of these DSS was either institutional or *ad hoc* (see section 4.5.2). All interviewees were computer proficient and were able to provide a meaningful business perspective on their organisation's DSS implementation.

To prevent any organisation from dominating the analysis, only one interview per organisation was conducted. In total, 27 interviews were personally conducted by the author, split between the following three categories:

- 15 DSS business managers;
- 4 in-house IS personnel; and
- 8 professional DSS consultants.

### 8.4.4 Testing and Analysis

Once the research data had been collected, the empirical generalisations needed to be tested. The approach that was used to analyse the data was based on the answers as provided. This was supplemented by the author's interpretation of the responses to the open-ended questions in Part Three of the questionnaire instrument (see Appendix E).

For Part Two of the questionnaire instrument, each of the 28 statements was on a 5-point Likert scale intended to obtain information on a respondent's attitude towards a specific CSF evidence item. Cooper and Emory (1995) state that statements must meet two criteria:

- each statement is believed to be relevant to the attitude being studied; and
- each is believed to reflect a favourable or unfavourable position on that attitude.

All 28 statements were equally weighted. Each of the interviewee's responses to these statements was scored with the following scale values: "Strongly Agree" - 5; "Agree" - 4; "Uncertain" - 3; "Disagree" - 2; and "Strongly Disagree" - 1. This approach is widely adopted (see, for example, Gemoets and Mahmood, 1990; Cooper and Emory, 1995; and Lai, 1996). For statements 21 and 22, the scale values were scored in the reverse sequence (*i.e.* "Strongly Agree" - 1; *etc*). Each interviewee's responses to each statement were added to obtain a total score for the organisation. There was one respondent per organisation.

The completed questionnaires were analysed to quantify the interviewees' responses and to estimate the degree of perceived success in DSS implementation (see section 1.2). In addition, for each organisation, an item analysis (see Cooper and Emory, 1995) was carried out to validate the degree of discrimination for each evidence item. Statements which were good discriminators were used in the analysis. The frequency of evidence items for successful and not successful organisations was quantified.

## 8.5 Summary

In this chapter an overview of methodologies used for IS research areas was given. The empirical methodology that was used to conduct this research, the administering of the questionnaire instrument and the analysis of the results were stated.

After establishing the theoretical basis of the research, it is possible to evaluate the validity of the results and conclusions in context. This aspect will be dealt with in the next chapters.

# Chapter 9

## RESULTS AND FINDINGS

### 9.1 Introduction

The empirical generalisation stated in section 8.3.4 was that for the successful implementation of DSS in organisations in KwaZulu-Natal, all nine previously extracted CSFs are found in the 27 surveyed organisations. The CSFs are:

- User Involvement;
- Top Management Support;
- User Training;
- Information Source;
- Level of Managerial Activity being Supported;
- User Information Satisfaction;
- Relative Use;
- Perceived Utility; and
- Goal Realisation.

Each of the CSFs in this empirical generalisation will be examined in section 9.3 in order to ascertain its respective relative importance in determining the success (or failure) of DSS implementations in KwaZulu-Natal.

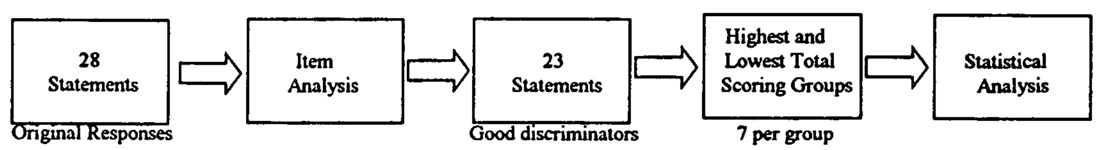
### 9.2 Statistical Analysis

Jaccard and Becker (1990) state that the discipline of statistical analysis has traditionally been divided into two major subfields: descriptive statistics and inferential statistics. The researchers indicate that the two are highly related to one another and in some respects the distinction is arbitrary. Descriptive statistics involves the use of numerical indices to describe either a population or a sample (as in this research). The goal is to *describe* a group of scores in a clear and precise manner. In contrast, inferential statistics involves taking measurements on a sample and then from the observations, making inferences about a population. For the purposes of this research, focus will be on descriptive statistics.

### 9.2.1 Item Analysis

The flow of data from the 27 interviewees' responses to the 28 statements in Part Two of the Structured Interview Questionnaire (see Appendix E) through to the statistical analysis phase, is shown in Figure 9.1.

**Figure 9.1 Data flow from Interviewee's responses to Statistical Analysis phase**




The item analysis procedure evaluates an item based on how well the item discriminates between those respondents whose total score is high and those whose total score is low (Cooper and Emory, 1995). The most popular type using this approach is summated scales. Summated scales consist of statements that express either a favourable or unfavourable attitude toward an object of interest. The respondent is asked to agree (or disagree) with each statement. Each response is given a scale value (see section 8.4.4) to reflect the respondent's degree of attitude. In this research, a 5-point Likert scale with scale values from 1 to 5 was used. The scale values are used to produce a total score for each respondent's attitude.

Cooper and Emory (1995) indicate that each interviewee's response must first be added to secure a total score. The next step is to array these total scores and select the respondents at each end with the highest and lowest *total scores* (*e.g.* the top 25 per cent and the bottom 25 percent). As the sample size for this research was 27 organisations, from the scale values in Appendix G, the highest seven (top

25 per cent) and lowest seven (bottom 25 percent) total scores were selected. The middle 13 total scores were excluded. These total scores from Appendix G are reflected in Figure 9.2.

**Figure 9.2 Highest Seven and Lowest Seven Total Scores**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Highest Seven Total Scores | 129 | 120 | 120 | 117 | 116 | 114 | 113 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lowest Seven Total Scores | 94 | 92 | 92 | 92 | 90 | 90 | 79 |

The associated range, mean and standard deviation for each of these two groups are indicated in Figure 9.3.

**Figure 9.3 Associated Range, Mean and Standard Deviation for each Group**

| Statistical Calculation | Highest Seven Total Scoring Group | Lowest Seven Total Scoring Group |
|---|---|---|
| **Range** | 96 - 112 | 61 - 77 |
| **Mean** | 101.0 | 72.3 |
| **Standard Deviation** | 5.1 | 5.1 |

These two extreme groups (highest seven total scoring and lowest seven total scoring) represent the most favourable and least favourable attitudes toward the topic being studied. As suggested by Cooper and Emory (1995), they were used as the criteria for evaluating individual statements.

Item analysis involves calculating the mean scores for each scale item (*i.e.* statement number) among the low scorers and high scorers. The statement item means between the high scoring group and the low scoring group were then tested for significant difference by calculating *t* values. From the scale values in Appendix F, the associated *t* values for each of the 28 statements contained in Part Two of the questionnaire instrument (see Appendix E), are shown in Figure 9.4.

**Figure 9.4 Associated *t* values for each Statement Number**

| Statement Number | Associated *t* value |
|---|---|
| 1 | 3.67 |
| 2 | 1.69 |
| 3 | 3.11 |
| 4 | 2.41 |
| 5 | 1.84 |
| 6 | 3.56 |
| 7 | 3.13 |
| 8 | 2.10 |
| 9 | 2.72 |
| 10 | 2.45 |
| 11 | 2.76 |
| 12 | -1.06 |
| 13 | 2.04 |
| 14 | 1.16 |
| 15 | 2.38 |
| 16 | 2.05 |
| 17 | 2.27 |
| 18 | 0.00 |
| 19 | 2.76 |
| 20 | 2.56 |
| 21 | 1.81 |
| 22 | 0.18 |
| 23 | 2.85 |
| 24 | 3.69 |
| 25 | 2.45 |
| 26 | 3.58 |
| 27 | 3.18 |
| 28 | 2.07 |

As an approximate indicator of a statement's power, only those statements whose *t* value is 1.75 or greater should be used (Edwards, 1957). Consequently, the shaded areas (statement numbers 2, 12, 14, 18 and 22) are excluded from the statistical analysis. From Figure 8.5 (CSFs and associated Evidence Items) an "adjusted" CSFs and associated Evidence Items table was constructed which excluded statement numbers 2, 12, 14, 18 and 22. See Figure 9.5.

**Figure 9.5 "Adjusted" CSFs and associated Evidence Items**

| CSF | Associated Evidence Item Statement numbers |
|---|---|
| User Involvement | 1, 5, 17 |
| Top Management Support | 3, 11 |
| User Training | 4, 6, 7 |
| Information Source | 8, 9, 10, 23 |
| Level of Managerial Activity Being Supported | 13, 15 |
| User Information Satisfaction | 16, 19, 20 |
| Relative Use | 21 |
| Perceived Utility | 24, 25, 26 |
| Goal realisation | 27, 28 |

From Figure 9.4 and Appendix F, an "adjusted" total score for each of the 27 surveyed organisations was calculated. The "adjusted" highest seven and lowest seven total scores are reflected in Figure 9.6.

**Figure 9.6 "Adjusted" Highest Seven and Lowest Seven Total Scores**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Highest Seven Total Scores | 112 | 103 | 102 | 99 | 98 | 97 | 96 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lowest Seven Total Scores | 77 | 76 | 76 | 73 | 72 | 71 | 61 |

From Figures 9.4 and 9.5, the number of CSFs found in each of the seven highest total scoring and seven lowest total scoring organisations was extracted. The criterion for judging whether a CSF was present in an organisation was that each associated evidence item statement number (indicated in Figure 9.5) had to have a minimum scale value (see section 8.4.4) of 4. The number of CSFs found present in each of the seven highest total scoring and seven lowest total scoring organisations is shown in Figure 9.7.

Figure 9.7 **Number of CSFs found present for the Seven Highest and Seven Lowest Total Scoring Organisations**

| Organisation's Total Score | No of CSFs found present |
|---|---|
| 112 | 9 |
| 103 | 8 |
| 102 | 7 |
| 99 | 8 |
| 98 | 7 |
| 97 | 7 |
| 96 | 8 |

| | |
|---|---|
| 77 | 2 |
| 76 | 4 |
| 76 | 2 |
| 73 | 1 |
| 72 | 3 |
| 71 | 1 |
| 61 | 2 |

In order to determine whether a linear relationship exists between an organisation's total score and the associated number of CSFs found present in the organisation, an hypothesis test was made. The hypothesis was that this was a one-tailed lower-tail test with $H_0$: the number of CSFs identified does not decrease linearly with the total value of points scored, and $H_1$: the number of CSFs identified does decrease linearly with the total value of points scored.

From Figure 9.7, Pearson's product-moment coefficient of linear correlation $r$ = 0,941 was calculated. The number of degrees of freedom was 12. The table values (critical values of the coefficient of linear correlation), see Melville and Goddard (1996), are 0,458 (5% level) and 0.612 (1% level). It can therefore be concluded that $H_1$ can be accepted at the 1% level. This tends to suggest that there is a strong association between the total value of points scored by organisations and the number of CSFs found in the surveyed organisations in KwaZulu-Natal.

From the seven organisations which recorded the highest total scores and the seven organisations which recorded the lowest total scores, a summary of the frequency of each CSF is given in Figure 9.8.

**Figure 9.8 Frequency of CSFs found present in Highest and Lowest Total Scoring Organisations**

| CSF | Frequency of CSFs found in Organisations | |
|---|---|---|
| | Highest Total Scoring Group | Lowest Total Scoring Group |
| User Involvement | 7 | 0 |
| Top Management Support | 7 | 2 |
| User Training | 7 | 0 |
| Information Source | 5 | 3 |
| Level of Managerial Activity Being Supported | 5 | 5 |
| User Information Satisfaction | 6 | 2 |
| Relative Use | 7 | 3 |
| Perceived Utility | 7 | 0 |
| Goal realisation | 3 | 0 |

From Figure 9.8 an analysis was made to ascertain which CSFs were "totally" supported by all seven surveyed organisations which recorded the highest total scores. Of the nine previously identified CSFs, only five were totally supported by all these organisations. See Figure 9.9.

**Figure 9.9 CSFs "totally" supported by all organisations from the highest total scoring group**

| CSF |
|---|
| User Involvement |
| Top Management Support |
| User Training |
| Relative Use |
| Perceived Utility |

The four CSFs "totally" not supported by all seven organisations which recorded the highest total scores are shown in Figure 9.10.

**Figure 9.10 CSFs "totally" not supported by all organisations from the highest total scoring group**

| CSF |
|---|
| Information Source |
| Level of Managerial Activity Being Supported |
| User Information Satisfaction |
| Goal realisation |

There were no CSFs "totally" supported by the seven organisations which recorded the lowest total scores. See Figure 9.11.

**Figure 9.11 CSFs "totally" supported by all organisations from the lowest total scoring group**

| CSF |
|---|
| "No entries" |

### 9.2.2 Questionnaire Instrument Reliability

From Appendix F, the data was tested for reliability using Cronbach's Alpha. Where Likert-type scales are used in DSS research, Cronbach's Alpha is a commonly used coefficient of reliability (see, for example, Doll and Torkzadeh, 1988; Whyte, 1995; and Lai, 1996). Figure 9.12 reflects for each CSF, the associated number of evidence item statements and corresponding Cronbach's Alpha.

**Figure 9.12 CSFs, associated number of Evidence Item Statements and corresponding Cronbach's Alpha**

| CSF | Number of Evidence Item Statements | Cronbach's Alpha |
|---|---|---|
| User Involvement | 3 | 0.6 |
| Top Management Support | 2 | 0.7 |
| User Training | 3 | 0.6 |
| Information Source | 4 | 0.6 |
| Level of Managerial Activity Being Supported | 2 | 0.8 |
| User Information Satisfaction | 3 | 0.6 |
| Relative Use | 1 | 0.8 |
| Perceived Utility | 2 | 0.6 |
| Goal realisation | 2 | 0.8 |

Nunnally (1978) suggests an Alpha score above 0.7 for reliability. However, Alpha scores of at least 0.6 are considered an acceptable level for this type of research (Srinivasan, 1985). From Figure 9.12, all CSFs in the survey instrument achieved this minimum level of reliability. This suggests an adequate level of internal consistency of the questionnaire instrument used in this research. Whatever the instrument is measuring, it must be doing so consistently (Whyte, 1995).

9.2.3 Respondent's Grading of Organisation's DSS Implementation

The grading of each organisation's DSS as successful, partially successful or not successful is an assessment by the respondents interviewed. Their responses are shown in Appendix G. A summary of their assessments is as follows:

| | | |
|---|---|---|
| Successful organisations | : | 14 organisations. |
| Partially successful | : | 7 organisations. |
| Not successful | : | 6 organisations. |

From the item analysis, the seven organisations which scored the highest total scores, were all assessed by their respondents as having been successful with their DSS implementations. For the seven organisations which scored the lowest total scores, five organisations were assessed to be partially successful and two organisations were assessed to be not successful by the respondents interviewed.

Using the scale values from Appendix F and the respondent's assessment of their organisation's DSS implementation (see Appendix G), the "Top Nine" evidence items for the fourteen successful organisations is reflected in Figure 9.13. The order is ranked mean score descending.

Similarly, using the scale values from Appendix F and the respondent's assessment of their organisation's DSS implementation (see Appendix G), the "Bottom Nine" evidence items for the six not successful organisations is reflected in Figure 9.14. The order is ranked mean score ascending.

Figure 9.13 "Top Nine" Evidence Items for Successful Organisations

| Rank | Statement Number | Mean Score | Standard Deviation | Associated CSF |
|---|---|---|---|---|
| 1 | 3 | 4.6 | 0.5 | Top Management Support |
| 1 | 25 | 4.6 | 0.5 | Perceived Utility |
| 1 | 27 | 4.6 | 0.5 | Goal realisation |
| 2 | 4 | 4.4 | 0.5 | User Training |
| 2 | 10 | 4.4 | 0.5 | Information Source |
| 2 | 11 | 4.4 | 0.5 | Top Management Support |
| 2 | 23 | 4.4 | 0.6 | Information Source |
| 2 | 15 | 4.4 | 0.6 | Level of Managerial Activity Being Supported |
| 2 | 21 | 4.4 | 0.6 | Relative Use |

Figure 9.14 "Bottom Nine" Evidence Items for Not Successful Organisations

| Rank | Statement Number | Mean Score | Standard Deviation | Associated CSF |
|---|---|---|---|---|
| 1 | 28 | 2.3 | 0.5 | Goal Realisation |
| 2 | 7 | 2.5 | 1.3 | User Training |
| 2 | 6 | 2.5 | 1.3 | User Training |
| 4 | 24 | 2.7 | 0.5 | Perceived Utility |
| 5 | 27 | 2.8 | 0.9 | Goal Realisation |
| 5 | 3 | 2.8 | 1.1 | Top Management Support |
| 5 | 23 | 2.8 | 1.1 | Information Source |
| 5 | 8 | 2.8 | 1.2 | Information Source |
| 5 | 10 | 2.8 | 1.2 | Information Source |

An analysis of the frequencies (and percentages) of each scale value (excluding statement numbers 2, 12, 14, 18 and 22) for all fourteen successful and six not successful DSS organisations is shown in Figure 9.15.

The range, mean and standard deviations of total scores for all fourteen successful and all six not successful organisations is given in Figure 9.16. Statement numbers 2, 12, 14, 18 and 22 are excluded from the total score calculations.

Figure 9.15 Summary of Frequencies (and percentages) for each Scale Value

| Scale Value | Successful Organisations | | Not Successful Organisations | | All Organisations Surveyed | |
|---|---|---|---|---|---|---|
| 5 | 108 | (33.6%) | 15 | (10.9%) | 141 | (22.7%) |
| 4 | 163 | (50.6%) | 59 | (42.7%) | 303 | (48.8%) |
| 3 | 13 | (4.0%) | 29 | (21.0%) | 70 | (11.3%) |
| 2 | 31 | (9.6%) | 28 | (20.3%) | 86 | (13.8%) |
| 1 | 7 | (2.2%) | 7 | (5.1%) | 21 | (3.4%) |

Figure 9.16 Summary of Range, Mean and Standard Deviation for Organisations

| Statistical Calculation | Successful Organisations | Not Successful Organisations | All Organisations interviewed |
|---|---|---|---|
| Range | 86 - 112 | 61 - 86 | 61 - 112 |
| Mean | 95.4 | 76.8 | 87.4 |
| Standard Deviation | 6.9 | 8.5 | 11.5 |

## 9.3 Findings

The structured interviews resulted in some of the evidence items being strongly supported and other issues also emerged. From the item analysis (see section 9.2.1) and Parts One and Three of the questionnaire instrument (see Appendix E) and considering each CSF in turn, the author's findings are now discussed.

### 9.3.1 User Involvement CSF

All seven highest total scoring organisations indicated that there must be significant user involvement during the project. In one organisation the DSS developer and user was the same person. Three of the seven highest total scoring organisations and none of the seven lowest total scoring organisations rated User Involvement as the most important factor which contributed most significantly to their organisation's DSS success.

Six of the highest total scoring organisations reported an "owner" of the DSS. The reason for the seventh organisation not having an "owner" was the fact that the institutional DSS had only recently been implemented and the organisation had not yet officially named the DSS owner. In the case of the highest total scoring organisations, six of the organisations reported that owners were non-IT personnel (*e.g.* general managers, financial directors). The seventh organisation reported that a dual ownership existed: a mixture between both the DSS user (from a business perspective) and the IT department (from a technical perspective). This was also evidenced in the lowest total scoring organisations where ownership was sometimes vested with the IT department. For these organisations some of the interviewees stated that regarding their DSS they "didn't know who the owner was", or "the owner has left the organisation" or "it was supposed to go to the users but it still vests with IT". Turban (1996) notes that the user is left with a system at the end of a project: if the user does not "own" the system from a psychological point of view, the system is unlikely to be successful. DSS ownership, as a potential CSF for DSS implementation, is an avenue for future research.

### 9.3.2 Top Management Support CSF

Top management support has long been recognised as one of the most important ingredients necessary for the introduction of any organisational change (Turban, 1992). A group of researchers (see, for example, Neal and Radnor, 1973; Lucas, 1975; and Ives and Olson, 1984) hypothesized that top management support was *the* key factor in determining success (Garrity and Sanders, 1998). However, Laudon and Laudon (1998) warn that sometimes management support can backfire. This occurs when management becomes overcommitted to a project, pouring excessive resources into a development effort that is failing or should never have been undertaken in the first place (Newman and Sabherwal, 1996). However, in this study this stance could not be confirmed. Furthermore, management support may be less essential for small organisations (see sections 10.3.5 and 10.4.5) that do not have the resources found in highly developed bureaucraticies of large organisations.

Meredith (1981) cites nineteen references that underscore the Top Management Support phenonemon in IS. Turban (1992) reports that if top management advocates and devotes full attention to a system, the chances of successful implementation are enhanced. Furthermore, he states that if top management *initiates* the project, the likelihood of success increases markedly. Sanders and Courtney (1985); and Kaiser and Srinivasan (1980) both concluded that the support of top management was critical to DSS success. The author's results serve to underscore these previous studies.

Organisations successfully introducing DSS regard it as a strategic, important direction actively supported by management. All the highest total scoring organisations had a DSS "champion" (sometimes referred to as a "project sponsor") either when interviewed or when implementation first took place. The champion in these organisations was not only at IT Manager level, sometimes it was even at the financial director level. This ensured support from senior management. As one respondent succinctly noted " if we would not have had a project champion, we would not have succeeded without him". This status was not always present in the lowest total scoring DSS implementing organisations.

From the seven highest total scoring organisations, three identified Top Management Support as the factor which contributed most significantly to their organisation's DSS success. Three of the seven lowest total scoring organisations cited Top Management Support as the factor which contributed most significantly to their organisation's DSS failure. This serves to underscore Turban's (1996) research that the most consistent finding across implementation studies is the importance of *management support and leadership* in successful implementation. Top Management Support was the second CSF totally supported by all organisations from the highest total scoring group.

### 9.3.3 User Training CSF

All seven highest total scoring organisations reported that their organisations regarded training as important. User Training was the third CSF totally supported by all organisations from the highest total scoring group. However, the time and costs spent in training their users was not documented. Not all respondents confirmed whether training had been properly conducted, whether it had been timeous and whether there had been enough allocated time to conduct thorough training. They felt that the individual users needed to be consulted. Two of the seven lowest total scoring organisations regarded training as "not applicable" as the respondents were of the opinion that training was an integral part of the evolutionary process of DSS implementation. Those users who had been trained, had such training conducted "in house" (see section 10.2.2).

### 9.3.4 Information Source CSF

Thierauf (1992) states that many top managers are finding that information is a source of competitive power. Turban (1995) notes that executives are recognising that IS allow organisations to compete and sometimes even to survive. However, the findings of this research do not provide any conclusive evidence in support hereof. Turban (1998) is of the opinion that in today's environment with the "interaction with existing systems and the web", information source is a very important CSF for successful DSS implementation. See section 10.5.3.

Even though two of the respondents from the highest total scoring organisations reported that not all the information was always readily available, in all cases it was nevertheless always current. In the case of the lowest total scoring organisations, four of the seven respondents reported that the required information was readily available. They too reported that in all cases the information as current. For this latter group of respondents, the term "current" had different connotations (*e.g.* data from a month-end file, data captured from a previous population census) and this may be a possible explanation for not ascribing a relative sense of recency to the information source.

From the seven lowest total scoring organisations, one respondent rated Information Source as the factor which most significantly contributed to the organisation's DSS implementation failure. Another organisation from this group rated Information Source CSF conversely.

### 9.3.5 Level of Managerial Activity being Supported CSF

Two of the seven highest total scoring organisations rated the abovementioned CSF as the most important factor which contributed least significantly to their organisation's DSS success. In analysing all fourteen organisations (from the seven highest total and seven lowest total scoring groupings), thirteen organisations reported that their DSS facilitated better decisions even though some implementations were not entirely successful. The respondent of the fourteenth organisation (the only exception) cited the fact that he was able to make equally good decisions with the organisation's previously installed DSS and the latest DSS implementation enabled him with "no better decision-making". This tends to indicate that for the majority of all organisations some benefit was derived from the DSS as partial decision-making was facilitated. This supports Walden's (1996) recent findings.

From the seven highest total scoring organisations, most of the respondents reported that the speed at which they analysed decisions had increased. Only one organisation was not able to confirm this as the organisation had only completed its DSS implementation a few days prior to the interview.

### 9.3.6 User Information Satisfaction CSF

The satisfaction of users with the "final" product and the acceptability of the DSS to users is an important measurement for the evaluation of DSS success. Six of the seven highest total scoring organisations agreed on all the evidence items. In the seventh case, one respondent reported that as he was the project "champion", he was not the main user. Therefore he was not able to confirm the existence of all the associated evidence items (statements 16, 19 and 20. See Figure 9.5).

Three of the seven lowest total scoring organisations reported that they had a difficult-to-understand user interface and this may be ascribed to their organisation's DSS implementation failure.

### 9.3.7 Relative Use CSF

The Relative Use CSF was found present in all seven highest total scoring organisations. It was the fourth CSF totally supported by all organisations from the highest total scoring group.

Six of the seven highest total scoring organisations reported a high usage of their respective DSS. Frequencies ranged from hourly, daily, weekly and monthly depending on the organisation's particular environment. In the seventh organisation, the respondent indicated that the organisation's DSS was only used during a four to five month period during the year. This occurred during the organisation's annual strategic planning exercise. During this period there is a relative high use of the DSS but thereafter it becomes dormant. Consequently there is relative high use of this DSS only during a fixed annual period.

The use of a TPS (see section 3.1) is seldom voluntary (Mallach, 1994). As this researcher notes, with DSS the option to make a decision without computer input is always there and raises the question "Should people be forced to use the computer?". Mallach (1994) suggests that there is no single right answer to this question. Even though Statement 18 ("I use the DSS on a voluntary basis") from Part Two of the Structured Interview Questionnaire (see Appendix E) was excluded from the item analysis, an analysis of the interviewee's responses shows that three of the seven highest total scoring organisations and six of the seven lowest total scoring organisations reported that their DSS was used on a voluntary basis. For the highest total scoring organisations, three respondents indicated that they were indirectly "forced" to use their organisation's DSS in the sense that there was no alternative system available to each of them. One respondent indicated that he was not "forced" to use his organisation's DSS. Instead the interviewee felt that usage was not strictly voluntary but that it rather formed part of a daily procedure.

From the highest and lowest total scoring organisations, one organisation from each group reported that the Relative Use CSF was the factor which had least significantly contributed to their respective organisation's DSS success.

The above results tend to underscore the findings of Welsch (1986) whereby DSS success may be measured by a frequency of use (if the use is voluntary). The use of such measures is well established in cases where such system use is voluntary (see, for example, Swanson, 1974; King and Rodriguez, 1978; Robey, 1979; Ginzberg, 1981a; and Fuerst and Cheney, 1982). This is also confirmed by Turban (1996) who adopts "high levels of use" as a sign for successful implementation.

During the interviews no assessment was undertaken on the cognitive style measures in relation to system usage.

9.3.8 Perceived Utility CSF

Watson (1998) reports that the Perceived Utility CSF is one of the top five CSFs for successful DSS implementation. Perceived Utility was the fifth CSF totally supported by all organisations from the highest total scoring group.

In earlier research conducted by Averweg and Erwin (1998, 1999), the Perceived Utility CSF was the only factor found to be present in all successful and unsuccessful organisations in KwaZulu-Natal which have implemented DSS. In this research, this finding was not supported. The previous results may be attributed to smaller sample sizes and that item analysis was not used in this earlier research. In the current research it is also significant to note that for the lowest total scoring organisations **none** of these seven organisations reported the Perceived Utility CSF as present.

For the highest total scoring organisations there was consensus that the DSS is perceived as an important system for the organisation. A reservation was expressed by an organisation from the lowest total scoring group. The respondent recorded that whilst he personally believed the DSS to be important, the same opinion may not be shared by some users who display a resistance to change with the introduction of new technologies. This tends to suggest that whenever DSS implementation programmes are initiated, cognisance should be taken of possible psychological barriers and DSS context issues (*e.g.* cultural, organisational, task, role or individual-related). With South Africa's great racial and cultural heterogeneity, these should not be overlooked. These issues interact and influence each other and may impact on DSS success.

### 9.3.9 Goal realisation CSF

Only three of the highest total scoring organisations reported that the DSS expectations had been met. From Figure 9.8 it is observed that the Goal realisation CSF was the least common CSF present in organisations which had implemented DSS in KwaZulu-Natal.

One organisation had only completed its implementation a few days prior to the interview. Consequently no evaluation had been conducted by that organisation to establish whether any shortcomings existed with the achievements and whether all expectations had been fulfilled. Another organisation reported that the results achieved had far exceeded earlier expectations and hence a (positive) gap existed between what the DSS was expected to achieve and what was actually achieved. The respondent for this organisation also rated the Goal realisation CSF as the factor which contributed most significantly to the organisation's DSS success.

Two of the seven lowest total scoring organisations reported a divergence between the expected and actual achievements. This may reflect exaggerated expectations of their organisation's DSS. (It should be recalled that as associated evidence item (statement 12) was found to be a poor discriminator of attitude ($t$ value = -1.06), it was excluded from the item analysis).

A possible limitation of this CSF is discussed later in section 10.3.3.

## 9.4 Indication of Previously Unrecognised CSF

At the end of each interview, the interviewee was asked whether there were any additional factors which contributed to his organisation's DSS implementation. Some of the interviewees' responses could not be classified into one or more of the nine identified CSFs. This led the author to suspect that there may be another CSF in existence. In addition to the above CSFs an **additional and previously unrecognised** CSF was indicated: the ability to utilise appropriate DSS tools (see section 10.4.6) was a significant issue mentioned by six (of the seven) highest total scoring organisations and the inability to accomplish this was an issue for all seven lowest total scoring organisations. Therefore, although the intention of the research was to explore previously reported CSFs, successful DSS organisations were also successful users of appropriate DSS tools and the less successful organisations either experienced difficulties or limitations with this aspect when attempting to implement their DSS.

There is support for this additional CSF in the recent personal insights of noted DSS researchers Efraim Turban and Daniel Power. Turban (1998) states that nowadays there is a new factor which he describes as "availability of commercial software development tools" and Power (1998) reports "using an appropriate software development tool set". The current insights and opinions of these two researchers will be discussed in sections 10.5.3 and 10.5.5.

## 9.5 Conclusions

In the light of the findings as reported in this chapter, it is evident that the empirical generalisation as stated in section 8.3.4 is only *partially* true. As the testing and results have revealed strong evidence for only five of the nine stated CSFs, the empirical generalisation in its previously stated form must therefore be rejected as it is not totally supported by this research.

Even though the empirical generalisation cannot be accepted, the author is of the opinion that the five identified CSFs and the previously unrecognised CSF must nevertheless each be given careful consideration when embarking on DSS implementation programs in KwaZulu-Natal.

## 9.6 Summary

In this chapter statistical analysis of the data was conducted: item analysis, calculation of Pearson's product-moment coefficient of correlation ( $r =$ 0,941) and Cronbach's Alpha.

The findings of the research were discussed by considering each CSF item in turn. Only five of the nine previously identified CSFs were found to be present in surveyed KwaZulu-Natal organisations which had implemented DSS. There was also an indication of a previously unrecognised CSF. In the light of the testing and findings, the previously stated empirical generalisation was not accepted as it could only be partially supported by this research.

# Chapter 10

## CONCLUSIONS, LIMITATIONS AND FURTHER EXPLORATION AREAS

### 10.1 Introduction

From the analysis of the results presented in Chapter 9, the implications for management wishing to embark on DSS programs in KwaZulu-Natal are discussed. Some of the limitations of this research are identified and further exploration areas are suggested.

### 10.2 Conclusions

As Crossman *et al* (1995) indicate, wise judgement is needed when deciding on the selective use of IT. It is felt that this is particularly relevant to DSS. No matter what can, or has been undertaken in other developed countries, the extremes of optimism or pessimism are likely to be wrong. The author suggests support for Odedra *et al* (1993) that instead of trying to "catch up" with the industrialized world, South Africa follows the route that extreme care must be exercised by all the parties involved in the transfer of technology from one country to another.

#### 10.2.1 Implications for Management: Is 'critical' critical?

Figure 9.9 showed that organisations embarking on DSS implementation must ensure that five CSFs, *viz.* User Involvement, Top Management Support, User Training, Relative Use and Perceived Utility are properly addressed during the implementation process. These CSFs were found to be present in all organisations in the highest total scoring group. All seven organisations in the highest total scoring group (as determine by item analysis) were all perceived by their respective respondents to be successful with their organisation's DSS implementations. These findings suggest that the remaining four CSFs may not be critical, in the sense that they are "absolutely necessary" to ensure success

(Rockart, 1979; and Fidler and Rogerson, 1996). This does not imply that the remaining four CSFs (see Figure 9.10) need not be addressed but the author contends that it may be inappropriate to regard the remaining four CSFs as "critical". Consequently, a contingency approach is suggested by labelling them as "important but not essential for success".

### 10.2.2 CSFs present Highest Scoring Group and absent in Lowest Scoring Group

From Figure 9.8, there were three CSFs (User Involvement, User Training and Perceived Utility) found in all organisations in the highest total scoring group that were absent in all organisations in the lowest total scoring group:

- **User Involvement CSF**. Historically, it has been an accepted premise that user involvement is a success factor for successful IS implementation (Garrity and Sanders, 1998). However, in reviewing the literature on user involvement, Ives and Olson (1984) found "that much of the existing research (has been) poorly grounded in theory and methodologically flawed; as a result, the benefits of user involvement (have) not been convincingly demonstrated". Consequently these researchers have turned to theories of organisational behaviour and change for user involvement research. These theories are, however, not discussed here. All organisations in the highest total scoring group had an owner of the DSS but this was absent in many of the lowest total scoring group organisations (see section 9.3.1). It is contended that with the absence of this motivating factor (*i.e.* perceived ownership of the DSS) in the lowest total scoring organisations, mitigated against these organisations being successful with their DSS implementations. As Garrity and Sanders (1998) indicate, motivating factors (*e.g.* perceived ownership of system, decreased resistance to change) are the intervening factors between user involvement and the expected outcome of higher levels of user acceptance of the system. The author's findings suggest support for earlier research but is of the opinion that user involvement is a *critical* success factor for successful DSS implementation.

- **User Training CSF**. Effective user training is a bottom line issue (Garrity and Sanders, 1998). Organisations can either take the time and expenses to adequately train employees up front or allow employees to learn new processes on the job. Operational users are trained in system structure and functions (Turban, 1995). Users are also trained how to maintain the system.

  There is no panacea for correct training. Garrity and Sanders (1998) state that many organisations "continue to err" by using procedural training, which explains exactly how a user is to use the system based on functions. They suggest a better approach is conceptual model training in which users are presented with overviews of how the system is organised and *how* the system works. This empowers users to solve problems on their own and dramatically improves user proficiency and satisfaction with the system.

  Effective user training provides a significant return on investment when implementing new processes (Garrity and Sanders, 1998). It can be provided by various sources ranging from "in house" to the vendor (see section 10.2.4) who provides the DSS generator. End user training is very important in DSS implementation (Turban, 1995). The author's findings confirms this viewpoint.

- **Perceived Utility CSF**. Joshi's (1991) equity-implementation model, based on equity theory as its foundation, attempts to explain variations in the user's reaction to change caused by the implementation of IS. If the individual perceives the outcome of the IS implementation to be one of inequity, their involvement component may then be negatively affected (Garrity and Sanders, 1998). If the user perceives no change or gain in their equity status, the increased levels of (user) involvement may lead to greater levels of outcome satisfaction and consequently higher levels of IS success. The findings of this study supports this view in the sense that both the Perceived Utility and User Involvement CSFs were found to be present in the highest total scoring organisations (and all perceived to be successful by their respective respondents) but these CSFs were absent in the lowest total scoring group.

### 10.2.3 DSS Designer-User Relationship

Turban (1996) suggests that there is a need to concentrate on the relationship between DSS designers and users. This viewpoint is strongly echoed by Keen (1998) who states that "the designer-user relationship" is "far more critical" than the previously identified CSFs for DSS implementation, as "without that, the best technical system rarely actually gets used". In this study no attempt was made to quantify this assertion and this may be an avenue for further research.

The quality of designer-user interactions has itself been the focus of a sizeable body of research (see, for example, Churchman and Schainblatt, 1965; Boland, 1978; Ginzberg, 1981b; and Ives and Olson, 1984). During the early stages of the DSS design process, it is important for the individuals involved with the system to develop trust in each other's objectives and competence. The designers have to want to help users and users must be willing to spend time working with designers and on their part of the design to develop a cooperative relationship. If those involved become adversarial, Turban (1996) states that the system is doomed. Consequently, during the design process, a major objective is for users to accept ownership of the system.

### 10.2.4 External DSS Vendors

From an analysis of interviewee's responses from less successful organisations, it appeared that the support levels offered by external DSS vendors was limited. This sentiment was not echoed by the more successful organisations. This tends to indicate that DSS support levels should be evaluated by organisations prior to embarking on DSS implementation programs.

#### 10.2.5 Summary of Guidelines

Organisations not confining themselves to these guidelines are likely to be dissatisfied in the medium term. Work continues to enlarge the coverage of organisations which should serve to produce statistically better results.

In summary, this study suggests support for six CSFs for successful DSS implementation in organisations in KwaZulu-Natal. These CSFs are User Involvement, Top Management Support, User Training, Relative Use, Perceived Utility and the newly recognised Appropriate DSS Tools. Even though the existence of the other success factors in developed countries is recognised from the literature survey, the author's findings suggest that they are *not critical* to successful DSS implementation in KwaZulu-Natal organisations. CSFs should serve South Africa's own needs rather than echoing those of developed countries.

### 10.3 Limitations of the Research

It is possible to identify several potential limitations of this research. These are:

#### 10.3.1 Sample size

McCosh's (1994) research into factors common to the successful implementation of DSS and how they differ from failures, was based on fifteen organisations. Steer's (1995) research of CSFs for the implementation of EIS in South Africa included 22 respondents. The author's research included 27 organisations. Even though this is a larger sample size, it is still relatively small. It may therefore still be dangerous to infer too much on a general basis from the evidence collected during these 27 interviews. For example, with item analysis, Edwards (1957), suggests when using statements whose *t* value is 1.75 greater, there should be 25 or more subjects in each group. On this basis, the sample size for this research could have been larger.

### 10.3.2 Sample selection

The sample selection included representatives from the business, technical and professional arenas. The respondents were relatively senior members of organisations. Possibly more senior executives could have been interviewed as Mittman and Moore (1984) report that DSS supports broader aspects of decision-making than is frequently assumed. In hindsight, some more junior respondents of the various organisations should also have been identified and these research findings may have been more representative of the KwaZulu-Natal DSS market. Furthermore, for financial and logistical reasons, the sample selection did not include respondents from the other eight provinces in South Africa.

Scholtz (1996) notes that in "the current South African context" an increasing number of people from a variety of cultural backgrounds are moving into decision-making positions. The researcher suggests that as this "dilutes the previously homogenous decision-making identity" and with the exposure of these people to DSS, their responses to DSS implementations will need to be gauged. In addition to gender and culture, other factors such as religion (see, for example, Siker *et al*, 1991), cognitive style, computer literacy and even a choice of undergraduate major (see Paradice and Dejoie, 1991) have been found to impact on decision-making behaviour. As discussed in section 6.5.1, with different decision styles, the *use* of DSS may differ.

### 10.3.3 Survey Instrument: Limitations of Questionnaire

During the interview process, it became apparent that sometimes a statement from the survey instrument had different interpretations by different respondents. For example, statement 12 in Part Two of the Structured Interview Questionnaire (see Appendix E) required a respondent to indicate whether there was a "gap between what the DSS was expected to achieve and what was actually achieved". This can be viewed in four scenarios: If on the one hand the original expectations were not very high, and what was actually achieved was low, there may be no perceived gap. If what was actually achieved was very high, then there would be a large (positive) gap. If on the other hand the original expectations were very high, and what was actually achieved was low, there may be a large (negative) gap. If what was actually achieved was also very high, then there may be no perceived gap. See Figure 10.1 and section 6.5.3. This limitation was not uncovered by the validation process. The author thus accepts some limitations in the questionnaire used.

**Figure 10.1 Possible Responses to Statement 12 in Part Two of Structured Interview Questionnaire**

| Original Expectation | Actual Achievement | Gap Perception |
|---|---|---|
| Not Very High | Low | No gap |
| Not Very High | Very High | Large (positive) gap |
| Very High | Low | Large (negative) gap |
| Very High | Very High | No gap |

### 10.3.4 Case study methodology

It was indicated in section 8.2 that Van Horn (1973) is of the opinion that case studies provide little insight into the key research issues of IS. More recent literature suggests that case studies are commonly used in DSS research issues. See, for example, Gray (1994). It can therefore be argued that a deeper insight may have been obtained using a case study approach (as discussed in section 8.2). Such an approach would have allowed the researcher to concentrate on a smaller number of organisations identify more subtle trends over time which were possibly not apparent during the interviews. Even though all respondents were willing to assist in this research, a number of respondents may not have felt comfortable with an in-depth case study of their organisation's DSS. Some factors cited by Gray (1994) were time constraints and sensitivity of their organisation's data. This research did not extend the data gathering to include case studies.

### 10.3.5 Other DSS Classifications

This research focused on institutional and *ad hoc* DSS in large well-established organisations. Recent research by Lai (1996) indicates that most DSS studies are confined to large organisations. A larger sample should also include GDSS (see sections 4.5.5 and 7.3.3), GIS (see section 2.8) and "personal DSS" (personal DSS are found in smaller organisations).

Snitkin and King (1986), who coined the term "personal DSS", suggest that these DSS depend on the features and applications that are valued by users. Raymond and Bergeron (1992) cite the example of a manager using a spreadsheet for financial modelling. He will be defined as having a personal DSS, "whatever the complexity of the task". Personal DSS seem more appropriate for small organisations (see, for example, Hayen, 1982; Lincoln and Warberg, 1987; Chen, 1989; and du Toit, 1995). For a recent empirical assessment of the usage of DSS applications in small businesses, see Lai (1996).

## 10.4 Further Exploration

During this study, the following areas of possible further research were identified:

### 10.4.1 The Ranking and Relationships of CSFs

The author set out to identify those CSFs which have been previously identified by researchers and to establish whether they are in existence in organisations in KwaZulu-Natal which have implemented DSS. It was found that it was inappropriate to label each of these CSFs as "critical". The relative degree of importance (*i.e.* by ranking) of each of these needs to be established. As Bullen and Rockart (1981) observe, some further insight is often gained by having the CSFs placed in priority order. As these researchers state, absolute priorities are not essential; general indicators of what the interviewee views as most important will suffice. They caution that many managers will not prioritise CSFs as it is not necessary to do so. Since they are, "after all, a small high-priority set of things", all of them are critical. They add that quite often no one is more critical than the others.

The relationship among these CSFs can be further explored. For example, top management support is considered an environmental factor (Turban, 1995). Research should check its co-existence with other independent variables (*e.g.* user behaviour) or on a dependent variable (*e.g.* quality of decision made).

### 10.4.2 Focusing on a specific CSF

Each of the nine CSFs identified, represents a complete research project in its own right. During the research, the author briefly touched on each concept but is aware that there are other issues surrounding each concept that were not identified during the research, such as the possible ways of measuring each CSF. The reason(s) for the "rejection" of five evidence items (statement numbers 2, 12, 14, 18 and 22 from the questionnaire instrument) being poor discriminators of attitude (see figure 9.4), should be further explored. As Bullen and Rockart (1981) state, focusing on a specific CSF is an area for great creativity. Further research needs to be undertaken on each of the nine CSFs and to verify the existence and extent of the newly identified CSF (see section 10.4.6).

### 10.4.3 Cross-functional differences

The author is of the opinion that useful inferences can be drawn by analysing the DSS implementation CSFs from three different perspectives: business, professional and technical. Even though this research did draw on the response from each of these perspectives, the objective of this research was *not* to identify the gaps in the opinions of each area. The author contends that some DSS failures can be attributed to a disparity between the differing understandings of what is *critical* to DSS. More DSS implementations may succeed if these disparities were identified and solved. Steer (1995) suggests a similar approach for EIS implementations in South Africa.

10.4.4 Industry differences

A potential area for research is to identify the CSFs which are specific to a particular industry. This research combined the data from respondents who represented a number of different industries which resulted in generic CSF guidelines for organisations wishing to embark on DSS implementations. However, this may only be the springboard. Once the organisation has identified the generic issues highlighted in this study, there may be other issues which need to be considered that are specific to the particular industry in which the organisation operates.

10.4.5 DSS in Smaller Organisations

As indicated in section 10.3.5, "personal DSS" are found in smaller organisations. Even though DSS tends to focus on large organisations (as in the case of this research), it would be useful to make a meaningful comparison between these two groups of organisations in seeking to establish how DSS implementations differ. As Raymond and Bergeron (1992) report, managers were found to be more successful when they develop their own numeric applications using spreadsheets to provide greater analytical support for decision-making.

10.4.6 Ability to Utilise Appropriate DSS Tools

Sprague and Watson (1996) indicate that DSS tools are hardware and software elements built by a toolsmith to facilitate the development of both specific DSS (systems that actually support the manager or user to solve specific sets of related decision problems) and DSS generators. See Figure 2.3. Examples of such DSS tools include programming languages, graphics and colour subroutines and other dialog-handling software.

In section 9.4, the author identified an additional and previously unrecognised CSF; namely the ability to utilise appropriate DSS tools. It was found that successful DSS organisations were also successful users of appropriate DSS tools. Further research needs to identify the existence and extent of the newly identified Appropriate DSS Tools CSF.

### 10.4.7 International DSS Perspectives

Towards the end of this research, the author approached some internationally recognised DSS researchers regarding this work. Their individual opinions are discussed in the next section.

## 10.5 CSFs for DSS Implementation: International Perspectives

Using the "snowball" sampling technique (see section 8.4.3), sixteen international DSS researchers were each asked for their individual opinions based on their individual personal experiences on the nine previously identified CSFs. A total of eight responses (all personal e-Mail communications) was received. The DSS researchers, their affiliations and the date of their responses (where received) are reflected alphabetically in Figure 10.2. The shaded areas indicate the eight DSS researchers who did not respond.

**Figure 10.2 International DSS Researchers, Affiliation and Date of e-Mail Responses**

| Researcher | Affiliation | Date of e-Mail Response |
|---|---|---|
| Berkeley, D. | London School of Economics, England | |
| Carlsson, C. | Åbo Akademi University, Finland | |
| Davis, G.B. | University of Minnesota, USA | |
| Dolk, D., 1998 | Naval Postgraduate School, USA | 27 May 1998 |
| Gray, P. | Claremont Graduate School, USA | |
| Holsapple, C.W. | The University of Kentucky, USA | |
| Keen, P.G.W., 1998 | International Centre for Information Technologies, USA | 12 June 1998 |
| Lim, K. | University of Hawai'i, USA | |
| Power, D., 1998 | University of Northern Iowa, USA | 28 May 1998 |
| Sauter, V. | University of Missouri, USA | |
| Sprague, R.H., 1998 | University of Hawai'i, USA | 14 April 1998 |
| Turban, E., 1998 | California State University, USA | 27 May 1998 |
| Walden, P., 1998b | Åbo Akademi University, Finland | 24 August 1998 |
| Watson, H., 1998 | University of Georgia, USA | 25 May 1998 |
| Whinston, A.B. | The University of Texas at Austin, USA | |
| Widmeyer, G.R., 1998 | University of Michigan, USA | 21 August 1998 |

The researchers' comments reflect current insights into CSFs for DSS implementation and may also represent a springboard for further research. The eight respondents (in date order of their responses) commented as follows:

### 10.5.1 Ralph Sprague

This researcher stated "I do not have any specific references to similar research. There is a comprehensive bibliography of DSS references in my most recent book with Hugh Watson, in case it would be helpful" (Sprague, 1998). The bibliography includes 14 books and 180 references. See Sprague and Watson (1996).

### 10.5.2 Hugh Watson

Watson (1998) indicated that in his opinion, the top CSFs were:

1. Top Management Support
2. Goal realisation
3. User Involvement
4. Perceived Utility.

CSFs 1, 3 and 4 were all found in organisations from the author's highest total scoring group (see Figure 9.9). Watson (1998) adds that another important CSF is Business Need. The associated evidence items for this CSF need to be identified.

### 10.5.3 Efraim Turban

Turban (1998) is of the opinion that "the old factors are much less important in today's environment" and adds that "the real factors are the new ones, not the old stuff of the 1970s and 1980s". He does, however, confirm the importance of the Information Source CSF and Top Management Support for OLAP (see section 2.8).

This researcher is of the opinion that nowadays, there are "new" factors, such as:

1. Availability of commercial software development tools
2. Interaction with existing systems and the web
3. Availability of data warehouse.

CSF 1 was also identified by the author as a previously unrecognised CSF (see section 9.4). With current DSS trends (see section 2.8), it is anticipated that strong advances in several areas of technology (*e.g.* World Wide Web and data warehousing) will combine to impact the field of DSS (Sprague and Watson, 1996). Turban's CSFs 2 and 3 will therefore play a future role in the DSS environment.

10.5.4 Dan Dolk

Dolk (1998) states that in his opinion, the "top ones" on the list are:

1. Top Management Support
2. Information Source
3. Perceived Utility
4. User Involvement
5. User Training.

From this list, four of the five CSFs, namely CSFs 1, 3, 4 and 5, were all found in organisations from the author's highest total scoring group (see Figure 9.9). With regards to the Information Source CSF, Dolk (1998) adds that "especially data quality" is important. As discussed in section 4.2.1, this data may include internal data sources, external data, private (personal) data belonging to one or more users or public data.

10.5.5 Daniel Power

Researcher Power (1998) contends that one needs to focus on the causes of DSS implementation success. His CSF opinions are:

1. Enthusiastic Top Management support
2. Realistic statement of the project scope that meets a decision need
3. Active involvement of ultimate end users in design, development and implementation
4. Qualified technical developers using an appropriate software development tool set
5. Effective co-ordination, communication and project management.

He states that "if these factors are substantially present, then the DSS implementation will be successful and Relative Use of the DSS will be high. Perceived Utility of the DSS will be high and Stated Goals of the DSS project will be realised". From this viewpoint all five CSFs reflected in Figure 9.9 are supported by Power (1998). Power's second stated CSF also gives support to Watson's (1998) Business Need CSF (see section 10.5.1). Power's fourth CSF echoes the author's findings of the previously unrecognised CSF, namely the ability to utilise appropriate DSS tools (see section 9.4).

10.5.6 Peter Keen

This researcher states that all the stated CSFs were important but adds that "far more critical is the designer-user relationship. Without that, the best technical system rarely actually gets used" (Keen, 1998). This viewpoint was discussed in section 10.2.3.

10.5.7 George Widmeyer

Widmeyer (1998) suggests that "what is more important than some quotes from other DSS researchers is what your own research shows about South African organisations' implementation of DSS". The author's research and findings (see chapter 9) are the essence of this study.

10.5.8 Pirkko Walden

Walden's (1998) opinions are:

1. Top Management Support
2. User Involvement.

From the author's research in KwaZulu-Natal organisations, both these CSFs were totally supported by all organisations from the highest total scoring group (see Figure 9.9). Walden (1998b) states that if the Top Management Support CSF is not placed first, "you will run into problems" and "our research project would not start a project without top management support".

With regards to the User Involvement CSF, the researcher indicates that "we develop DSS always together with the users (not for but with) - the users are involved from the first moment". This designer-user relationship sentiment tends to echo those of Power (see section 10.5.5) and Keen (see section 10.5.6). Walden (1998b) adds "when you involve the users in the development process it also means that you do not have to worry so much about the perceived utility".

## 10.6 Summary

The implications for management as to whether "critical" is absolutely necessary for DSS implementations was discussed. Some of the limitations of this research were noted. Finally, the potential areas for further research were discussed and some of the recent personal insights of internationally recognised DSS gurus was given. With constant *waves* of evolving technologies in IS, these personal anecdotes present a launch vehicle for exciting future work.

## 10.7 Personal Anecdote

Writing this research was a labour of love. I share this topic with the reader with zeal and enthusiasm. I think that these attributes are reflected in this work and make it better.

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**Examples of some commercially available OLAP Tools**
(It should be noted that this list is not complete)

| Product Name | Software Vendor |
|---|---|
| Acuity/ES | Acuity Management Systems |
| Acumen/Acumate | Kenan Systems |
| Adaytum | Adaytum |
| Advance | Lighten, Inc |
| Analysis Manager | Sardus Corporation |
| Brio | Brio Technology |
| Buisness Data Analyzer | Two To One |
| CrossTarget | Dimensional Insight, Inc |
| Decision View | Knosys LLP |
| Delta Solutions ALEA | MIS AG |
| Essbase | Arbor Software Corporation |
| Essbase Web Gateway | Arbor Software Corporation |
| InfoBeacon | Platinum Technology, Inc |
| Metacube | Informix |
| Neura | Mindware |
| Qbit | Zenia Software, Inc |
| QlikView | Qlik Tech |
| SAMAC MIT/400 | Samac Pty Ltd |
| SpaceOLAP/SpaceSQL | InfoSpace |
| WinHELM | Codework |
| Wired for OLAP | AppSource Corporation |

(Source: Internet URL http://www.sgroves.demon.co.uk/bi_products.htm, 30 July 1998)

# Appendix B

**Examples of some commercially available DSS Tools**
**(It should be noted that this list is not complete)**

| Product Name | Software Vendor | Comment |
|---|---|---|
| **Advance** | Lighten, Inc | |
| **ALFA** | MIS AG | A compact multidimensional database with a Microsoft Excel spreadsheet front end |
| **Ant Colony** | Geppetto's Workshop L.L.C. | |
| **Axiant** | Cognos, Inc | |
| **BrioQuery** | Brio Technology | |
| **BusinessObjects** | Business Objects | |
| **Commander OLAP** | Comshare | |
| **Commander Decision** | Comshare | |
| **CorVu** | CorVu (Pty) Ltd | |
| **CrossGraphs** | Belmont Research, Inc | |
| **DataTracker** | Silvon Software | |
| **DecisionSuite Server** | Information Advantage, Inc | |
| **DecisionSuite** | Information Advantage, Inc | |
| **Demos** | Lumina Decision Systems, Inc | A package for statistical risk and decision analysis |
| **Dimension Control** | Dimension Data Systems | A tool to analyse data from Essbase |
| **DSPlus** | Kelly Information Systems, Inc | A tool for retail and marketing analysis |
| **DSS Server** | MicroStrategy, Inc | |
| **DSS Agent** | MicroStrategy, Inc | |
| **DSS Web** | MicroStrategy, Inc | A tool for making multidimensional data accessible via Web browsers |
| **DynamiCube.OCX** | Data Dynamics Ltd | A multidimensional query tool for Visual Basic |
| **Empower** | Metapraxis | |
| **Enterprise Knowledge Server** | Metapraxis | |
| **Excel** | Microsoft Corporation | |
| **Express Analyzer** | Oracle | |
| **FISCAL Viewer** | Lingo Computer Design, Inc | |
| **GENTIA** | Planning Sciences | |
| **Holos** | Holistic Systems | |
| **Hyperion** | Hyperion Software | Financial data analysis and reporting tools |
| **Impromptu** | Cognos, Inc | |
| **Lightship Server** | Pilot Software | |
| **Lotus 1-2-3** | Lotus Corporation | |

| Product Name | Software Vendor | Comment |
|---|---|---|
| **Mathematica** | Wolfram Research | |
| **MATLAB** | The MathWorks, Inc | Numerical analysis and visualisation package |
| **Media** | Speedware Corporation, Inc | |
| **Oracle DSS** | Oracle Corporation | |
| **PaBLO** | Andyne | |
| **Pilot Decision Support Suite** | Pilot Software | |
| **PowerHouse** | Cognos, Inc | |
| **PowerPlay** | Cognos, Inc | |
| **Prism** | Prism Solutions | |
| **PV-Wave** | Visual Numerics, Inc | Data analysis and visualisation package |
| **S-Plus** | Statistical Sciences | Statistical analysis and visualisation package |
| **SalesTracker** | Silvon | |
| **SAS** | SAS Institute, Inc | Statistical analysis and visualisation package |
| **SPSS** | SPSS, Inc | |
| **StarTrieve** | SelectStar, Inc | |
| **TM1** | Applix, Inc | |
| **VentoMap** | Vento Software, Inc | Supplier of DSS for retail and distribution, financial and telecommunications applications |
| **Visigraph** | LMI, Inc | An add-on to Excel that supports graphical interface for information cognition |
| **Visualizer** | International Business Machines | |
| **Voyant** | Brossco Systems | |
| **WebOLAP** | Information Advantage, Inc | |

(Sources: Sprague and Watson, 1996 and
Internet URL http://www.cqminc.com/analysis.analsysis.htm, 30 July 1998)

# Appendix C

**Examples of some commercially available DSS Generators**
(It should be noted that this list is not complete)

| DSS Generator | Additional Reading |
| --- | --- |
| **Expert Choice** | Decision Support Software, Inc. 1983. *User's Manual.* McLean, VA. |
| **IFPS** | Execucom Systems Corporation. 1982. *IFPS User's Manual.* Austin, TX. |
| **Prefcalc** | Lauer, T.W. and Jelassi, M.T. December 1987. "PREFCALC - A Multi-Criteria Decision Support System: A User Tutorial", Indianan University Institute for Research on the Management of Information Systems, Working Paper #714. |
| **Lightyear** | Thoughtware, Inc. 1984. *LIGHTYEAR User's Manual,* Coconut Grove, FL. |

# PREAMBLE TO STRUCTURED INTERVIEW QUESTIONNAIRE

Computers have been used as tools to support managerial decision making for over three decades (Turban, 1995). The evolutionary view of computer-based information systems has led to the classification of the following major computerised support systems:

- Transactions Processing Systems (TPS);
- Management Information Systems (MIS);
- Decision Support Systems (DSS);
- Expert Systems (ES); and
- Executive Information Systems (EIS).

The attributes for each system classification are reflected in Figure 1.

Each interview conducted focused solely on the DSS classification. Whilst the existence of the "other" classifications is recognised and that some (or all) systems may exist in the interviewee's organisation, for the purpose of this study these are not considered. Each interview is concerned with the non-technical aspects (such as training, user satisfaction, usage, *etc*) and not with technical aspects (such as networks, hardware, programs, *etc*) of the interviewee's DSS.

Whilst different DSS definitions exist, the author considers Turban's (1995) minimum working definition of a DSS as appropriate :

> "*A DSS is an interactive, flexible, and adaptable computer based information system, specially developed for supporting the solution of a non-structured management problem for improved decision making. It utilises data, it provides easy user interface, and it allows for the decision maker's own insights*".

In essence these systems allow decision makers to access relevant data across the organisation as they need it to make choices.

**Figure 1 Attributes of the Major Computerised Support Systems**

| Dimension | Transactions Processing Systems (TPS) | Management Information Systems (MIS) | Decision Support Systems (DSS) | Expert Systems (ES) | Executive Information Systems (EIS) |
|---|---|---|---|---|---|
| Applications | Payroll, inventory, record keeping, production and sales information | Production control, sales forecasting, monitoring | Long-range strategic planning, complex integrated problem areas | Diagnosis, strategic planning, internal control planning, strategies | Support to top management decision, environmental scanning |
| Focus | Data transactions | Information | Decisions, flexibility, user friendliness | Inferencing, transfer of expertise | Tracking, control, "drill down" |
| Database | Unique to each application, batch update | Interactive access by programmers | Database management systems, interactive access, factual knowledge | Procedural and factual knowledge; knowledge base (facts and rules) | External (online) and corporate, enterprise wide access (to all databases) |
| Decision capabilities | No decisions | Structured routine problems using conventional management science tools | Semi-structured problems, integrated management science models, blend of judgment and modelling | The system makes complex decisions, unstructured; use of rules (heuristics) | Only when combined with a DSS |
| Manipulation | Numerical | Numerical | Numerical | Symbolic | Mainly numeric; some symbolic |
| Type of information | Summary reports, operational | Scheduled and demand reports, structured flow, exception reporting | Information to support specific decisions | Advice and explanations | Status access, exception reporting, key indicators |
| Highest organisational level served | Sub-managerial, low management | Middle management | Analysts and managers | Managers and specialists | Only senior executives |
| Impetus | Expediency | Efficiency | Effectiveness | Effectiveness and expediency | Timeliness |

(Source: Adapted from Turban, 1995)

# STRUCTURED INTERVIEW QUESTIONNAIRE

## PART ONE

### Demographics

Identify the organisation's business sector.

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Identify the respondent.

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What was your role during the DSS implementation?

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Describe your organisation's DSS environment.

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Before the DSS was implemented, how did you regard it succeeding in your organisation?

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Looking back, how do you regard your DSS implementation now?

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**Attributes**

Type of system (*e.g.* lone-user, *ad hoc*, institutional, GDSS, GIS).

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There was/was not a DSS steering committee.

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There was/was not a DSS project champion.

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Identify the team members who installed this DSS in your organisation.

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Who has accepted ownership of this DSS?

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State the current number of users of this DSS.

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Give the frequency that this DSS is used.

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## PART TWO

1. From the outset of the project, there was much user involvement.

   Strongly Agree Agree Uncertain Disagree Strongly Disagree

2. All managers agreed on the purpose of the DSS.

   Strongly Agree Agree Uncertain Disagree Strongly Disagree

3. Senior management was committed to the success of the DSS.

   Strongly Agree Agree Uncertain Disagree Strongly Disagree

4. The organisation regarded training as important.

   Strongly Agree Agree Uncertain Disagree Strongly Disagree

5. There was user involvement during all phases of the project.

   Strongly Agree Agree Uncertain Disagree Strongly Disagree

6. Every DSS user was properly trained.

   Strongly Agree Agree Uncertain Disagree Strongly Disagree

7. The training which was given was timeous.

   Strongly Agree Agree Uncertain Disagree Strongly Disagree

8. The information I require is always readily available.

   Strongly Agree Agree Uncertain Disagree Strongly Disagree

9. For me there is always a convenient access to the DSS information source.

   Strongly Agree Agree Uncertain Disagree Strongly Disagree

10. The information from my DSS is always current.

    Strongly Agree Agree Uncertain Disagree Strongly Disagree

11. There was tremendous support from senior management for the DSS.

    Strongly Agree Agree Uncertain Disagree Strongly Disagree

12. There is a gap between what the DSS was expected to achieve and what was actually achieved.

    Strongly Agree Agree Uncertain Disagree Strongly Disagree

13. Utilisation of DSS has enabled me to make better decisions.

    Strongly Agree Agree Uncertain Disagree Strongly Disagree

14. Use of data generated by DSS has enabled me to present my arguments more convincingly.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

15. As a result of DSS, the speed at which I analyse decisions has increased.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

16. I am always satisfied that the output information from my DSS is clear.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

17. From the outset, there was user involvement in the project.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

18. I use the DSS on a voluntary basis.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

19. I find that the format of the output information is easy to work with.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

20. My DSS has an easy-to-understand user interface.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

21. I do not use my DSS very often.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

22. I am forced to use the DSS.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

23. The system always provides me with up-to-date information.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

24. As a result of DSS, I am seen as more valuable in the organisation.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

25. All in all I believe that my DSS is an important system for the organisation.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

26. I have personally benefited from the existence of the DSS in my organisation.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

27. The most important goals of the DSS were realised.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

28. The DSS covers my entire decision making process.

Strongly Agree Agree Uncertain Disagree Strongly Disagree

## PART THREE

I believe that my organisation's DSS was very successful.

Strongly Agree     Agree     Uncertain     Disagree     Strongly Disagree

Record the respondent's rationale.

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Some researchers have identified the following factors as significantly important to DSS implementation:

**User Involvement**
**Top Management Support**
**User Training**
**Information Source**
**Level of Managerial Activity being Supported**
**User Information Satisfaction**
**Relative Use**
**Perceived Utility**
**Goal Realisation**

Which of the above factors contributed **most significantly** towards your organisation's DSS implementation?

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Which of the above factors contributed **least significantly** towards your organisation's DSS implementation?

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Other than the above, are there factors which you regard as contributing towards your organisation's DSS? If so, what are these?

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Record the respondent's rationale.

..........................................................................................................................

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# Appendix F

**Scale Values from Interviews Conducted**

| Respondent | Statement Numbers (From Part Two of Structured Interview Questionnaire) | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 1 | 5 | 4 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 5 | 5 | 5 | 4 | 5 | 2 | 5 | 5 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 2 |
| 2 | 5 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 5 | 5 | 4 | 2 | 5 | 5 | 5 | 4 | 4 | 1 | 4 | 4 | 5 | 1 | 5 | 4 | 5 | 4 | 5 | 2 |
| 3 | 2 | 5 | 5 | 4 | 2 | 4 | 4 | 2 | 2 | 4 | 5 | 1 | 5 | 2 | 5 | 5 | 2 | 2 | 4 | 4 | 5 | 4 | 5 | 4 | 5 | 2 | 5 | 4 |
| 4 | 4 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 5 | 5 | 2 | 5 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 5 | 4 | 5 | 4 | 4 | 2 |
| 5 | 4 | 3 | 5 | 4 | 4 | 2 | 4 | 5 | 2 | 5 | 5 | 2 | 4 | 5 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| 6 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 2 | 2 | 2 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 2 |
| 7 | 5 | 4 | 5 | 5 | 4 | 4 | 4 | 2 | 5 | 5 | 4 | 1 | 5 | 4 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 2 |
| 8 | 4 | 4 | 4 | 5 | 2 | 5 | 3 | 4 | 4 | 4 | 5 | 3 | 4 | 3 | 4 | 4 | 2 | 5 | 4 | 4 | 5 | 5 | 4 | 4 | 5 | 5 | 4 | 4 |
| 9 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 5 | 5 | 4 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 |
| 10 | 5 | 4 | 5 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 4 | 5 | 3 | 5 | 4 | 2 | 5 | 2 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 4 |
| 11 | 4 | 5 | 5 | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 3 | 5 | 5 | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 2 |
| 12 | 5 | 4 | 4 | 4 | 5 | 5 | 4 | 4 | 1 | 4 | 4 | 1 | 4 | 4 | 5 | 4 | 5 | 5 | 5 | 5 | 4 | 2 | 4 | 3 | 4 | 3 | 4 | 2 |
| 13 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 5 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 1 | 5 | 5 | 5 | 5 | 5 | 5 |
| 14 | 4 | 4 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 1 | 4 | 2 | 3 | 4 | 4 | 2 | 4 | 4 | 5 | 4 | 4 | 4 | 5 | 4 | 5 | 4 |
| 15 | 4 | 4 | 4 | 3 | 4 | 5 | 5 | 4 | 5 | 5 | 4 | 1 | 4 | 4 | 4 | 5 | 5 | 4 | 5 | 5 | 3 | 4 | 4 | 3 | 3 | 4 | 4 | 3 |
| 16 | 2 | 4 | 4 | 4 | 2 | 3 | 2 | 4 | 4 | 4 | 3 | 2 | 4 | 5 | 4 | 4 | 2 | 2 | 3 | 4 | 2 | 2 | 4 | 3 | 5 | 4 | 4 | 2 |
| 17 | 3 | 3 | 3 | 4 | 2 | 3 | 4 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 2 | 4 | 3 | 3 | 2 |
| 18 | 4 | 2 | 4 | 4 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 4 | 4 | 4 | 4 | 3 | 4 | 5 | 4 | 4 | 4 | 4 | 2 |
| 19 | 2 | 4 | 4 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 2 | 2 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 4 | 2 |
| 20 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 1 | 1 | 3 | 1 | 4 | 3 | 4 | 4 | 4 | 1 |
| 21 | 4 | 4 | 5 | 5 | 3 | 4 | 2 | 1 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 3 | 4 | 4 | 3 | 2 | 4 | 4 | 2 | 1 | 4 | 3 | 4 | 1 |
| 22 | 4 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 5 | 2 | 3 | 3 | 5 | 4 | 5 | 4 | 4 | 4 | 5 | 3 | 4 | 4 | 2 | 2 | 4 | 4 | 2 | 2 |
| 23 | 4 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 4 | 4 | 4 | 4 | 3 | 2 | 4 | 4 | 3 | 5 | 4 | 1 | 3 | 4 | 3 | 3 | 2 |
| 24 | 2 | 2 | 2 | 2 | 4 | 1 | 1 | 4 | 4 | 4 | 5 | 4 | 3 | 4 | 3 | 2 | 4 | 4 | 4 | 4 | 3 | 5 | 4 | 3 | 4 | 3 | 2 | 3 |
| 25 | 5 | 4 | 5 | 5 | 4 | 3 | 3 | 2 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 2 |
| 26 | 5 | 4 | 3 | 5 | 4 | 4 | 2 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 3 | 4 | 4 | 3 | 5 | 4 | 2 | 3 |
| 27 | 2 | 4 | 3 | 4 | 2 | 2 | 4 | 4 | 4 | 4 | 5 | 4 | 3 | 3 | 3 | 4 | 2 | 4 | 5 | 5 | 4 | 4 | 3 | 2 | 4 | 3 | 4 | 2 |

**Legend**

The digits reflected in the columns under the Statement Numbers represent the scale value of the interviewee's response to each statement number.

The shaded areas indicate the statement numbers which were excluded from the item analysis.

# Appendix G

**Respondent's Success Assessment, Total Scores and Ranking**

| Respondent | Respondent's Success Assessment | Total Score (Before Item Analysis) | "Adjusted" Total Score (After Item Analysis) | Ranked Total Score (After Item Analysis) |
|---|---|---|---|---|
| 1 | S | 120 | 103 | 2 |
| 2 | S | 110 | 98 | 5 |
| 3 | S | 103 | 89 | 13 |
| 4 | S | 116 | 99 | 4 |
| 5 | S | 112 | 93 | 10 |
| 6 | S | 101 | 86 | 16 |
| 7 | S | 120 | 102 | 3 |
| 8 | S | 113 | 93 | 10 |
| 9 | S | 105 | 87 | 15 |
| 10 | S | 117 | 97 | 6 |
| 11 | S | 109 | 89 | 13 |
| 12 | S | 108 | 92 | 12 |
| 13 | S | 129 | 112 | 1 |
| 14 | S | 109 | 96 | 7 |
| 15 | P | 112 | 95 | 8 |
| 16 | P | 92 | 77 | 21 |
| 17 | P | 92 | 73 | 24 |
| 18 | P | 114 | 95 | 8 |
| 19 | P | 94 | 76 | 22 |
| 20 | P | 92 | 76 | 22 |
| 21 | P | 90 | 72 | 25 |
| 22 | N | 101 | 82 | 19 |
| 23 | N | 79 | 61 | 27 |
| 24 | N | 90 | 71 | 26 |
| 25 | N | 103 | 83 | 18 |
| 26 | N | 107 | 86 | 16 |
| 27 | N | 97 | 78 | 20 |

**Legend**

Codes S, P and N denote the respondent's assessment of their organisation's DSS implementation. Code S indicates"Successful", code P indicates "Partially Successful" and code N indicates "Not Successful".