INSTRUMENT TO EVALUATE TO WHICH EXTENT THE OPERATIONAL SUPPORT INFORMATION SYSTEM (OSIS) ADDS VALUE TO THE South African Air Force (SAAF)

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Declaration

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

Signature: Date:

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ABSTRACT

Since the 1940s, the evaluation of information systems has been the topic of many authors' research. When taking into account the amount of resources invested in an organisation's information systems, especially in the present fiscal conditions, then the evaluation of an information system's success is imperative. Traditionally, monetary-based evaluation measures were used to evaluate the success of an information system, however, these types of measures were found to be inadequate in their attempt to measure the complexity of information systems successfully. Surrogate measures, such as the user's satisfaction with the information system, were developed to replace monetary-based evaluation measures. These forms of measures are often perceptual by nature and usually encompass the different stakeholders involved in the information system.

Information system evaluation measures usually focus on profitable organisations that account for the traditional measures that are monetary-based. However, with the infusion of information technology these days, even non-profit organisations, such as the South African Air Force (SAAF), recognise the importance of the success of information systems, even though monetary return on investment is a not a priority.

In the 1980s, a decision was made to develop a system that would support the SAAF's logistical and operational needs. This decision ultimately led to the development of OSIS. OSIS is a mission-critical system that supports force preparation activities. To date, no independent evaluation on the success of this system has been conducted; therefore an independent evaluation of OSIS was requested

This study is dedicated towards the development of an appropriate instrument that can be used to assess the value added by OSIS to the SAAF. Due to the magnitude of such an evaluation, the study only focused on the development of an appropriate instrument, to be used when conducting such an evaluation.

A unique research model was constructed to facilitate the research process. The research model required firstly that information regarding OSIS that will have an effect on the characteristics of the OSIS-value instrument, be obtained. Secondly, the research model required a review of current literature on the proliferation of measuring instruments available to do such an evaluation. Thirteen subjectively chosen measuring instruments/models were examined in terms of their appropriateness towards OSIS.

In terms of the unique nature of OSIS that is implemented in the SAAF, the reformulated DeLone and McLean IS success model was found to be the most appropriate measuring model. The appropriateness of this model is based on its multi-dimensional nature, which implies the inclusion of the views of different stakeholders in the OSIS environment. Four measuring instruments were chosen to evaluate each dimension of the model. However, some of the instruments' measuring items have some common characteristics, and it is proposed that further research be done to develop a streamlined instrument based on the reformulated DeLone and McLean IS success model.

OPSOMMING

Reeds in die 1940's was die evaluering van inligtingstelsels die onderwerp van baie navorsing. Wanneer ŉ mens die hoeveelheid hulpbronne wat in ŉ organisasie se inligtingstelsels belê word in ag neem, veral in die huidige ekonomiese klimaat, dan is die sukses van die evaluering van sodanige inligtingstelsel ŉ noodsaaklikheid. In die verlede is geldgebaseerde meetinstrumente gebruik om die sukses van ŉ inligtingstelsel te bepaal, maar navorsing het bewys dat daardie soort meetinstrumente nie voldoende was om die kompleksiteit van ŉ inligtingstelsel in ag te neem wanneer dit geëvalueer word nie. Surrogaatmeetinstrumente, soos die gebruiker se tevredenheid met die inligtingstelsel, is ontwikkel om geldgebaseerde evalueringsinstrumente te vervang. Dié surrogaatinstrumente word gewoonlik op die persepsies van die gebruiker se tevredenheid met die stelsel gebaseer en betrek gewoonlik die verskillende insethouers wat by die inligtingstelsel belang het.

Gewoonlik fokus evalueringsinstrumente vir inligtingstelsels op winsgedrewe organisasies. Maar, met die toename in inligtingstegnologie deesdae erken selfs nie-winsgewende organisasies, soos die Suid-Afrikaanse Lugmag (SALM), die noodsaaklikheid van die sukses van ŉ inligtingstelsel, selfs al is die monetêre opbrengs op belegging nie 'n prioriteit nie.

In die 1980's is ŉ besluit geneem om ŉ stelsel te ontwikkel wat aan die Suid-Afrikaanse Lugmag se logistieke en operasionele behoeftes bystand sou verleen. Dié besluit het gelei tot die ontwikkeling van OSIS. OSIS is ŉ missie-kritieke stelsel wat die mag se voorbereidingsaktiwiteite ondersteun. Tot op hede is daar nog nie ŉ onafhanklike evalueringsproses geloods om die sukses van OSIS te bepaal nie; daarom is daar om so ŉ onafhanklike evaluering gevra.

Hierdie navorsing fokus op die ontwikkeling van ŉ gepaste instrument wat gebruik kan word om te bepaal of OSIS waarde tot die Suid-Afrikaanse Lugmag toevoeg. As gevolg van die omvang van so ŉ evaluering, fokus die ondersoek net op die ontwikkeling van die instrument, wat dan later gebruik kan word om die evaluering te doen.

ʼn Unieke navorsingsmodel is ontwikkel om die navorsingsprobleem op te los. Die navorsingsmodel het eerstens vereis dat inligting rakende OSIS wat ʼn invloed op die eienskappe van die OSIS-waarde-instrument sal hê, verkry moet word. Tweedens het die navorsingsmodel vereis dat ʼn literatuurstudie oor die toename in meetinstrumente ten opsigte van inligtingstelsels gedoen moet word. Dertien evalueringsinstrumente/modelle is op subjektiewe wyse geselekteer om hulle toepaslikheid as OSIS-waarde instrument te bepaal.

Die ondersoek het bevind dat die *reformulated DeLone and McLean IS success model* die mees toepaslikste evalueringsmodel is vir OSIS se unieke omgewing. Die toepaslikheid van die model is gebaseer op die feit dat dit meer as een dimensie van die inligtingstelselomgewing inkorporeer. Vier evalueringsinstrumente is op subjektiewe wyse gekies om elke dimensie van die model te meet. Sommige van die instrumente het gemeenskaplike eienskappe en daar word voorgestel dat verdere navorsing gedoen word om ʼn meer vaartbelynde model, gebaseer op die *reformulated DeLone and McLean IS success model,* te ontwikkel.

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LIST OF ABBREVIATIONS

CALMIS	Computer-aided logistical management information system
DIMS	Depot information management system
DoD	Department of Defence
EPMS	Equipment program management system
IS	Information system
NLIS	Navy logistical information system
OMS	Operating management system
OSIS	Operational support information system
RAF	Royal Air Force
SA Army	South African Army
SAAF	South African Air Force
SAMHS	South African Military Health Services
SAN	South African Navy
SITA	State information technology agency
SLA	Service level agreement
SLIS	SAAF logistical information system
UIMS	Unit inventory management system
WSM	Weapon system manager

CHAPTER 1

INTRODUCTION TO RESEARCH

1.1 BACKGROUND

Starting with Shannon's Information Theory (Wyner, 1997) in the 1940s, the evaluation of Information Systems (IS) has been the topic of many authors' research (DeLone and McLean, 2002). An IS can be defined as "Interrelated components working together to collect, process, store, and disseminate information to support decision making, coordination, control, analysis, and visualisation in an organisation" (Laudon and Laudon, 2001). Traditionally, the evaluation of the success of an information system was based on tangible criteria, for example, return of investment (ROI), net present value (NPV), the internal rate of return (IRR) and the payback period (Martinsons, Davison, and Tse, 1999). However, continued research has revealed that intangible factors, such as "achieving its purpose" and "satisfied users" (DeLone and McLean, 2002; Jiang and Klein, 1999) should also be incorporated in the evaluation process.

In the current economic climate with its restricted budgets and high rate of project failures (Li, 1997), evaluating the success of an IS is imperative. Even in a non-profit organisation, such as the South African Air Force (SAAF), the importance of the success of an IS is essential even though monetary return on investment is not a priority.

The dramatic change in organisational and logistical requirements of the SAAF since its establishment in 1920 consequently influenced the changes in the SAAF's computing environment. In general, computer systems revolutionised from being transaction-processing systems in the 1950s to its current status as enterprise-wide information systems (Turban, Rainer and Potter, 2005). Centralised data processing systems (for example the Konvoor system in the 1970s that served the whole of the DoD), were ultimately replaced by a number of decentralised systems (for example OSIS that only serves the SAAF) (Bouwman, 2005a; Schultheis and Sumner, 1998).

In essence, OSIS is a mission-critical system, which supports force preparation activities (Bouwman, 2002). An independent evaluation was requested before additional funding would be provided for its further implementation. This study will focus on the development of an appropriate instrument that can be used to evaluate the value OSIS adds to the SAAF. Due to the magnitude of such an evaluation, this study only focused on the development of an appropriate instrument to be used to conduct such an evaluation.

1.2. LIMITATION

Although OSIS is implemented in the SAAF and SAN, this study considered the SAAF, and not the implementation of the expert modules in the SAN. Furthermore, this study focused only on the development of an appropriate instrument that can be used to evaluate the extent to which OSIS adds value to the SAAF.

1.3 RESEARCH PROBLEM

It was evident from a number of authors' research (Martinsons *et al.,* 1999; Saarinen, 1996; DeLone and McLean, 1992) that the traditional evaluation of IS success, which was based on monetary criteria, are seldom sufficient. This inefficiency has lead to the development of subjective and perceptual measures of system success such as user satisfaction instruments (Goodhue, Klein and Salvatore, 2000; Doll and Weidong, 1994; Ives, Olson and Baroudi, 1983). This shift in focus accommodated non-profitable organisations, which are not necessarily concerned about monetary issues.

OSIS is implemented by the SAAF, a non-profitable organisation. Thus far, no independent evaluation on the success of this system has been conducted. Currently, there is not an encompassing measuring instrument available that can be used to evaluate the extent to which OSIS adds value to the SAAF.

Against this background, an instrument will be developed to evaluate to which extent OSIS adds value to the SAAF. Due to the magnitude of such an evaluation, this study only focused on the development of an appropriate instrument to be used to conduct the evaluation.

1.4. PURPOSE OF STUDY

The aim of this study was to develop an appropriate measure, specifically aimed at evaluating whether OSIS adds value to the SAAF.

To reach this outcome, it was necessary to attain the following research objectives:

1. to obtain background information on OSIS that will have bearing on the development of the instrument;
2. to review prior studies on the evaluation of IS success; and
3. to develop an instrument based on the literature review and field information.

To make the study more informed, the following hypothesis was used: *A measuring instrument could be developed to determine whether OSIS adds value to the SAAF.*

1.5 CONTRIBUTION OF THE STUDY

The aim of research was to make a contribution to the existing body of knowledge. What is considered a contribution, is still a debatable question (Barett and Walsham, 2004). This study attempted to contribute to two sets of audiences: firstly, the SAAF with their attempt to evaluate the value of OSIS, and secondly, the information system scholars. This study attempted to make a contribution to the information system body of knowledge, having identified the gap that exists as a result of the absence of an appropriate instrument that could be used to conduct a formal evaluation on the value of OSIS to the SAAF.

1.6 EXPECTED RESULTS

Since the proposed study was directed towards the development of an OSIS-value instrument, it attempted to propose and motivate the appropriateness of the developed instrument. It was furthermore expected that this study would inspire the SAAF to recognise the value of OSIS and to strive to the more effective and efficient utilisation thereof within the DoD.

1.7 STRUCTURE OF THE STUDY

This study attempted to develop an appropriate instrument that can be used by the SAAF to evaluate the value that has been added by OSIS to the organisation. It was important to take into account the unique nature of the OSIS operating environment, due to the SAAF being a non-profitable organisation. In addition, attention was given to the fact that services are rendered to the users of OSIS by an outside organisation. In order to be successful in this attempt, care was given to the approach followed to obtain favourable results.

The study plan therefore followed the sequence as summarised below:

- *Chapter 1:* Introduction: A background chapter that presents the reasons for selecting this particular problem, the purpose for the study, as well as the statement of the research problem.

- *Chapter 2*: Research Methodology: A discussion of the research methodology followed in the study in order to investigate the problem as formulated above.

- *Chapter 3:* Background on OSIS: This chapter will review literature available on the development process and current operations of OSIS. The chapter also contributes relevant information that assisted in the development of the OSIS-value instrument.

- *Chapter 4*: Overview of instruments/model for the summative evaluation of an information system: A summary of the review of the literature available on prior studies on the evaluation of IS success will be presented in this chapter. Preliminary indications are often the appropriateness of each measuring instrument/model to the case of OSIS.

- *Chapter 5*: The arguments for an appropriate instrument are presented. This chapter also focuses on synthesising the data obtained in order to develop an instrument that can be used to evaluate the extent to which OSIS adds value to the SAAF.

- *Chapter 6*: Conclusion. The main conclusions of this study will be summarised and discussed.

1.8 PROMINENT TERMINOLOGY AND DEFINITIONS

The following terminology and definitions will be used throughout the thesis.

Centralised data processing systems

In the centralised data processing environment, a large mainframe computer system supports multiple users and multiple application programs. Users have access to computer resources via hundreds of remote computer devices, including on-line terminals used to input data and printers used to obtain reports (Schultheis and Sumner, 1998).

Decentralised data processing systems

In a decentralised data processing environment, minicomputers or microcomputers support local applications. Local systems and operations personnel are responsible for developing and maintaining programs and for managing computer operations (Schultheis and Sumner, 1998).

Enterprise-wide information system

An information system that encompasses an entire organisation, including both departmental systems and those of the entire enterprise (Turban *et al.,* 2005).

Information system

Interrelated components working together to collect, process, store and disseminate information to support decision-making, coordination, control, analysis, and visualisation in an organisation (Laudon and Laudon, 2001).

Information technology

The collection of computing systems used by an organisation (Turban *et al.,* 2005).

Non-profitable organisation (NPO)

An NPO is an organisation whose primary objective is to support some issue or matter of private interest or public concern for non-commercial purposes. Non-profit organisations may be involved in an innumerable range of areas relating to the arts, charities, education, politics, religion, research, or some other endeavour. Although NPOs do not operate to generate profit, they still need to generate revenue in order to finance their activities. However, the extent to which NPOs may generate income may be constrained, or the use of such income may be restricted. Non-profit organisations are therefore typically funded by donations from the private or public sector (Wikipedia, 2005).

Repertory grid technique

The repertory grid technique allows the elicitation of perceptions whilst minimising possible researcher interference or bias (Whyte, Bytheway and Edwards, 1997).

Service level agreement

A service level agreement (SLA) is an agreement that stipulates the expectations between the service provider and the customer and describes the products or services to be delivered. It is the single point of contact for end-user problems and the metrics, which monitors and approve the effectiveness of the process (Department of Defence, 1998).

Summative evaluation

Summative evaluation is a way of judging the worth of a program at the end of the program activities. The focus is on the outcome (What is summative evaluation, 1999).

Transaction processing system

An information system that supports the collection, processing and dissemination of data from the organisation's basic business transactions (Turban *et al.,* 2005).

CHAPTER 2

RESEARCH METHODOLOGY

"In Information Systems, there has been a general shift in IS research away from technological to managerial and organisational issues, hence an increasing interest in the application of qualitative research methods" (Myers, 2004).

2.1 INTRODUCTION

When reviewing the literature on the topic of IS evaluation instruments/models applicable to a specific case, it becomes clear that much of the research so far done in this area has conformed to the above observation by Myers (2004) and has been of a qualitative nature. The research approach for this study is of a qualitative and interpretive nature. As none of the general research methods available for qualitative research fitted this study, a unique research model was developed. This will be discussed in this chapter.

Following the colloquium, the scope of the study was changed. The research methodology, as described in the research proposal, also changed dramatically. These new research goals implied a new research methodology.

This chapter describes the research methodology that has been followed in order to obtain the new research goals. The research conducted for this study involved obtaining information from existing literature on evaluating the success of an IS and applicable information regarding the development, implementation and maintenance of OSIS.

Prior to the commencement of any study, the nature and the perspective of the study should first be established. The different research methods – both quantitative and qualitative methods – that put the specific research paradigm chosen for this study into context, are defined in this chapter. The qualitative research approach will be discussed further to highlight the different fundamental philosophical assumptions outlining qualitative research.

2.2 OVERVIEW OF RESEARCH APPROACH

Research can be classified either as quantitative or qualitative. *Quantitative research methods*, for example experiments and surveys¸ were initially developed in the natural sciences to study natural phenomena. *Qualitative research methods*, for example action research, case study research, ethnography and grounded theory, were developed in the social sciences to enable researchers to study social and cultural phenomena (Myers, 2005).

In this study, a qualitative research approach has been followed based on its characteristic to be “designed to help researchers to understand people and the social and cultural context within which they live” (Myers, 2005). As this research problem partially relates to an existing organisation, the SAAF, and is influenced by external factors, for example the dynamics of an IS, money available and competencies of the users of the system, it is clear that a qualitative research approach is appropriate.

Qualitative research is based on three or four fundamental philosophical assumptions (depending on the researcher and the classification) as to what amounts to “legitimate” research and which research methods are suitable. In the next section, these fundamental philosophical assumptions are discussed.

2.3 FUNDAMENTAL PHILOSOPHICAL ASSUMPTIONS

Research can sometimes be categorised into four (Myers, 2005) fundamental categories (paradigms): positivism, post-positivism, critical theory and constructivism. However, a three-fold classification of research can also be found (Myers, 2005): positivist, interpretive and critical. The present study will utilise these latter classification paradigms, which will be discussed briefly in this section.

The *Positivist paradigm* is characterised by its “inductive statistical methods, generalising a universal statement of truth from observations of a certain number of positive instances" (Bharadwaj, 2000). This paradigm tries to "explain and predict what happens in the social world by searching for regularities and casual relationships between its constituent elements" (Burrell and Morgan, 1979).

The *Interpretive paradigm* is characterised by "the belief that science is subjective and therefore allows alternative models of reality" (Bharadwaj, 2000). This paradigm is "informed by a concern to understand the world as it is, to understand the fundamental nature of the social world at the level of subjective experience. It seeks explanation within the realm of individual consciousness and subjectivity, within the frame of reference of the participant as opposed to the observer of action" (Burrell and Morgan, 1979). According to Bharadwaj (2000), the interpretive paradigm is important to IS research for several reasons, but most applicably in that it recognises the link between human elements and the technological aspect of IS.

The *critical paradigm* is "a brand of social philosophy which seeks to operate simultaneously at the philosophical, theoretical and practical level" (Burrell and Morgan, 1979). According to Myers (2005), the critical research paradigm stipulates that current situations are predefined by past actions and influences whether these be political, social or cultural influences. The focal point of critical research is to change the resistance, the disagreement and the challenges in present-day civilisation.

The research for this study was conducted by doing a literature review on IS evaluation models, and by interviewing people working actively in the environment in which OSIS is implemented. This research paradigm is clearly not positivist research but interpretive research. This is evident in the fact that this study tries to understand the "process whereby information systems are influenced" and is influencing the environment in which it is implemented (Myers, 2005).

2.4 RESEARCH MODEL

"A research method is a strategy of inquiry which moves from the underlying philosophical assumptions to research design and data collection. The choice of research method influences the way in which the research collects data. Specific

research methods also imply different skills, assumptions and research practices" (Myers, 2005).

Different qualitative research methods can be used, depending on the fundamental philosophical assumptions of the researcher. Action research, case study research ethnography, discourse analysis and grounded theory research are some of the research methods available for qualitative research (Myers, 2005).

In this study, none of the above-mentioned research methods was followed. This fact however, has led to the development of a research model (see Figure 2.1), specifically applicable to this study. The research process has been divided into three parts, as illustrated in Figure 2.1. These three parts will be discussed in the subsections below.

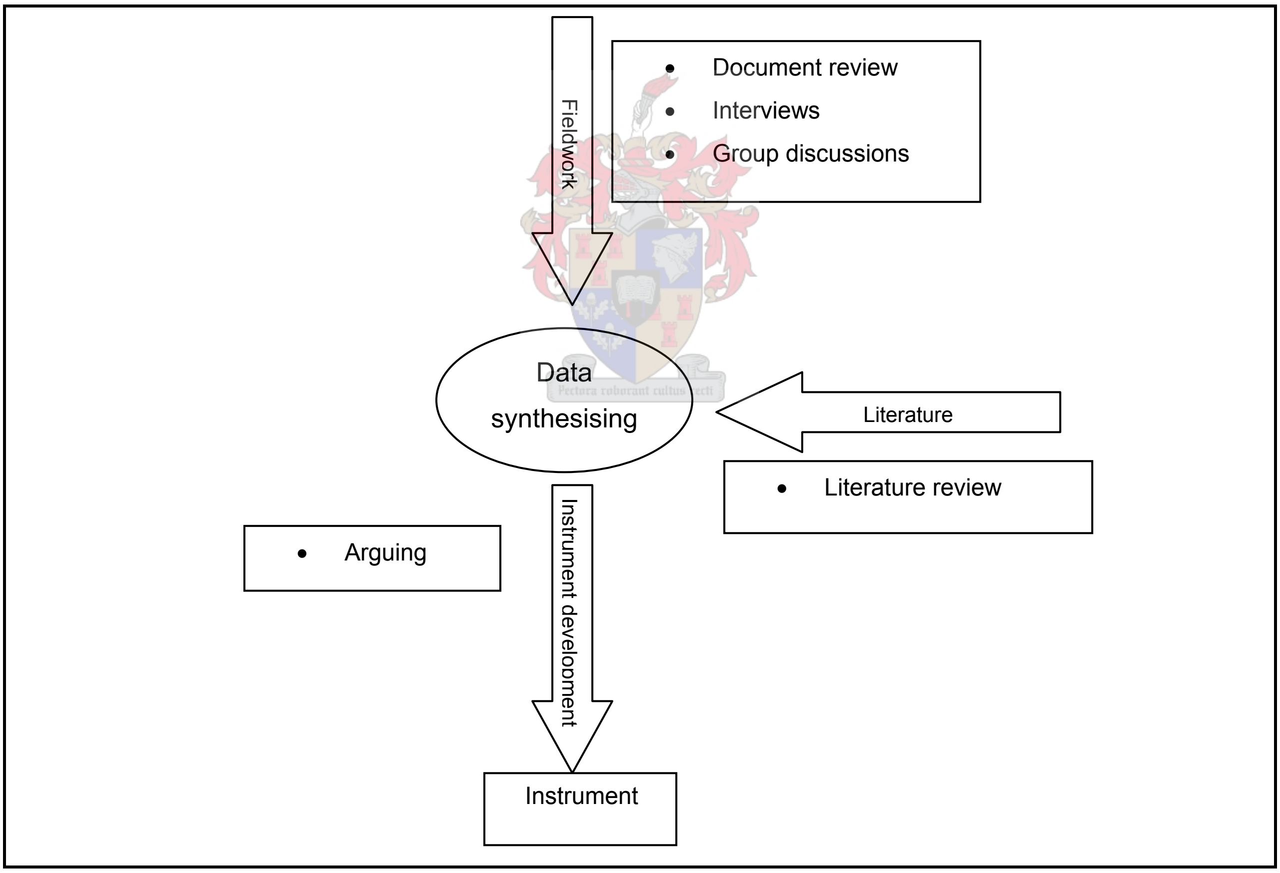

Figure 2.1: Research model

2.4.1 Fieldwork

In order to obtain more information about OSIS specifically, formal documents about the development and implementation of OSIS were reviewed. Interviews (sometimes in the form of group discussions) were conducted with the Senior Staff Officer (SSO) OSIS and other senior consultants who are permanently staffed at the SAAF, advising senior military officers on the use and implementation of OSIS.

2.4.2 Literature review

A literature review on the subject of evaluating the value/success of an IS, was done. Thirteen instruments were subjectively identified during the literature survey. Both works that formed the foundation in surrogate instruments (such as Davis, 1989; Ives *et al.,* 1983) and recent research (such as Tillquist and Rodgers, 2005; Marchand *et al.,* 2001a) were included in the review process. Subjectivity is derived from the fact that the instruments were identified on the basis of the researcher's opinion about the overall suitability and success of these instruments to obtain the research goal.

2.4.3 Data synthesis

Consise Oxford English Dictionary (1995) defines *synthesis* is as "The combining of separate elements or substances to form a coherent whole". Synthesising the data obtained from the literature review, interviews and document reviews, will bring the theory (of how) and practice (of what) together. By means of constructive arguments, this synthesised information will form the foundation for an appropriate OSIS-value instrument.

2.5 DATA COLLECTION

The data of this research can be classified into two categories: primary data and secondary data. Primary data can be defined as data that lies closest to the source of the truth underlying the phenomenon (Leedy, 1997). Secondary data, on the other hand, refers to written sources (including the Internet) which discuss, comment, debate and interpret primary sources of information (Mouton, 2001). The nature of each of these two types of data is discussed in the sections below:

2.5.1 Primary data

In the case of the present study, primary data was gathered through interviews and group discussions with key personnel in the OSIS environment and by observing the implementation of OSIS. Types of primary data collected are discussed below.

2.5.1.1 Telephonic interviews

Initially, telephonic interviews were conducted with Maj. M. de Wet (Mission Control Officer, CFS Langebaan Road), WO1 J. Cook (System Integrity) and Mr J. Schutte (Flight Safety and Data Integrity) in order to obtain information regarding OSIS and the views regarding the success of OSIS as perceived by the users.

2.5.1.2 Personal interviews

A personal interview was conducted with Col. W. Marais (SSO OSIS) to obtain managerial information regarding OSIS. A personal interview was also conducted with Mr P. Bouwman (business advisor) to obtain background, development, current implementation and future implementation information on OSIS. Notes were taken during the interviews. Any uncertainties, as a result of the speed at which notes were taken, were resolved by means of a telephonic interview or communication via e-mail afterwards.

2.5.1.3 Group discussions

Two group discussions held at different occasions, were used to obtain information regarding the background, implementation and use of OSIS.

A group discussion took place with representatives of the Royal Air Force (under the command of Sqn. Ldr. G. Jones) where the commercial equivalent of OSIS, LITS, is implemented. Also present at that discussion was Mr P. Bouwman (business advisor) and Maj. K. Pierce (OSIS Implementation and Strategy) representing the SAAF. The purpose of this focus group was to obtain information regarding the way the RAF evaluates LITS and probable elements the OSIS-value instrument should include.

Another group discussion was held with the three business advisors advising the SAAF on the continued use of OSIS. In addition, present at the group discussion was Col. W. Marais (SSO OSIS) and Mr J. Rossouw, an OSIS data analyst. These four members, with the exception of Col. Marais, were chosen to be present, instead of the directors themselves, by reason of their vast knowledge and experience of OSIS. These members have worked with OSIS since it started as SLIS in the early 1990s.

The only limitation having chosen this latter group to get insightful knowledge regarding the value of OSIS is that they are not considered users of OSIS. However, they do however interact daily with actual users regarding the use, modification and implementation of OSIS.

The initial idea was to interview the users (level 3), the middle managers (level 2) and the managers (directors) on level 1 to get information regarding the value OSIS adds to the SAAF. However, it was established that these directors do not have the necessary knowledge regarding OSIS; some of them have only been appointed to that position at the beginning of 2005 and have never worked on OSIS. The users, on the other hand, could present a wrong perception due to their lack of insight into the real problems associated with OSIS.

2.5.1.4 Observation

Maj. M. de Wet (2004), the Mission Control Officer at Central Flying School Langebaan Road, conducted a tour highlighting the major aspects of OSIS in the day-to-day running of CFS Langebaan Road. This tour helped the researcher to get a “feel” of OSIS, which was insightful in the understanding of what OSIS has contributed to the dynamic environment of the SAAF.

2.5.2 Secondary data

The following secondary data collection techniques were used.

2.5.2.1 Documents

To provide an insightful background on the development and implementation and business process of OSIS, the OSIS specification document (Bouwman, 2002), a CD ROM containing the OSIS User Orientation Material (SLIS 3.1AF User Orientation Material, 1998) and the Logistical System Master Plan III of the SAAF (South Africa, 1993) were reviewed.

2.5.2.2 Textbooks, journals, published articles, papers delivered at conferences and sources found on websites

The research for this study was done primarily through a review of literature comprising textbooks, journals, published articles, papers delivered at conferences and sources found on websites.

The data from the available sources utilised during the research process will be synthesised to conclude the data collection stage.

2.6 CONCLUSION

There are different qualitative research methods to do this type of research, but because of the unique nature of this study, none of the common research methods available for qualitative research was appropriate. A unique research model was therefore developed to address the requirements of the study.

This research model dictated the synthesising of two sets of data. The first set of data included the revision of formal documents about the development and implementation of OSIS. This data was supplemented with interview data acquired from business advisors who are permanently staffed at the SAAF. The second set of data was obtained from a literature review on thirteen subjectively identified instruments/models..

Both sets of data were then synthesised, and by means of constructive arguing motivation could be found regarding the appropriate instrument or combination of instruments to measure the extent to which OSIS adds value to the SAAF.

The research model is ideal for the task at hand because it is based on the uniqueness of the study and it can be easily adapted by other researchers for application on a different study.

CHAPTER 3

BACKGROUND OF OSIS

3.1 INTRODUCTION

The dramatic change in organisational and logistical requirements of the SAAF since its establishment in 1920 (Becker, 1993) consequently influenced the changes in the SAAF's computing environment. In general, computer systems revolutionised from being transaction-processing systems in the 1950s to enterprise-wide information systems (Turban *et al.,* 2005). Centralised data processing systems (for example the Konvoor system in the 1970s that served the whole of the DoD), were ultimately replaced by a number of decentralised systems (for example OSIS that serves the SAAF and SAN) (Bouwman, 2005a; Schultheis and Sumner, 1998).

During the 1980s, the SAAF identified the need for a master plan to direct the development of the SAAF logistical function. This resulted in the development of the Logistical System Master Plan (LSMP) that was published in 1993 (Bouwman, 2002).

The objectives of the LSMP were to serve as a blueprint and framework for the design, development and implementation of the Logistical System, with one of its elements being the development of a SAAF Logistical Information Systems (SLIS) to support the organisation in the execution and management of its logistical functions and processes.

This chapter attempts to provide an overview on the developmental and implementation processes of OSIS to obtain information that might contribute to the development of the OSIS-value instrument. The first part of this chapter will concentrate on presenting a background of OSIS, including a discussion of the logistical systems within the Department of Defence, the mission and functional overview of OSIS. The second part of the chapter will describe the value-adding factors experienced by the organisation following the implementation of OSIS, some negative aspects associated with OSIS and recommendations regarding the characteristics of the OSIS-value instrument.

3.2 BACKGROUND OF LOGISTICAL SYSTEMS WITHIN THE DEPARTMENT OF DEFENCE (DoD)

In 1970, the DoD utilised one mainframe-based logistical system, the Konvoor system, which served three of the four Arms of Service: SA Army, SAAF and SAN. The SAMHS had their own system, a modified Unit Inventory Management System (UIMS), to manage their logistical functions. In the 1980s, a decision was made in the DoD that the various services should display sufficient operational uniqueness to warrant the development of independent logistical IT systems (Bouwman, 2005a). The high level of autonomy in the services therefore led to the creation of three additional logistic systems.

The SA Army's modern logistical requirements are addressed by the CALMIS. This system provides logistic support to a mobile ground force, and is still under implementation at the Army and Special Forces units. This system provides for material management, weapon system management, maintenance management and fleet management functions (Bouwman, 2005a). The SAAF implemented their SLIS to provide modern logistical management. The system also provide weapon system management and strong preventative maintenance capabilities, as well as material management and fleet management functions (Bouwman, 2005a). The SAN made use of a derivative of SLIS, the NLIS. Although the systems were similar, two separate baselines were maintained (Bouwman, 2005a).

When the new generation of logistical information systems (CALMIS, SLIS, NLIS) was started, the intention was to phase out the logistical information system (LIMS) (LIMS could be a Unit Information Management System (UIMS) or a Depot Information Management System (DIMS)) once the new systems were able to replace the old systems. In practice, this has not yet been achieved. As illustrated in Figure 3.1, the LIMS still supports all three (tri-service) arms of service to some degree (Bouwman, 2005a).

In October 1996, a decision was made to rewrite SLIS and NLIS from the fourth-generation proprietary language known as ASSYST to UNIFACE, also a fourth-generation, internationally recognised programming language, as part of a stabilisation and risk reduction programme (Bouwman, 2005a). In the interim, Paradigm System Technology sold SLIS as the equipment programme management system (EPMS) product to the Royal Air Force (RAF), the British Army and the French Army (see Figure 3.1). The RAF named their version LITS, the British Army named their version SIMAT and the French Army named their version ACCES. The RAF further developed the engineering modules of OSIS and the French Army further developed the material management modules of OSIS (Bouwman, 2005).

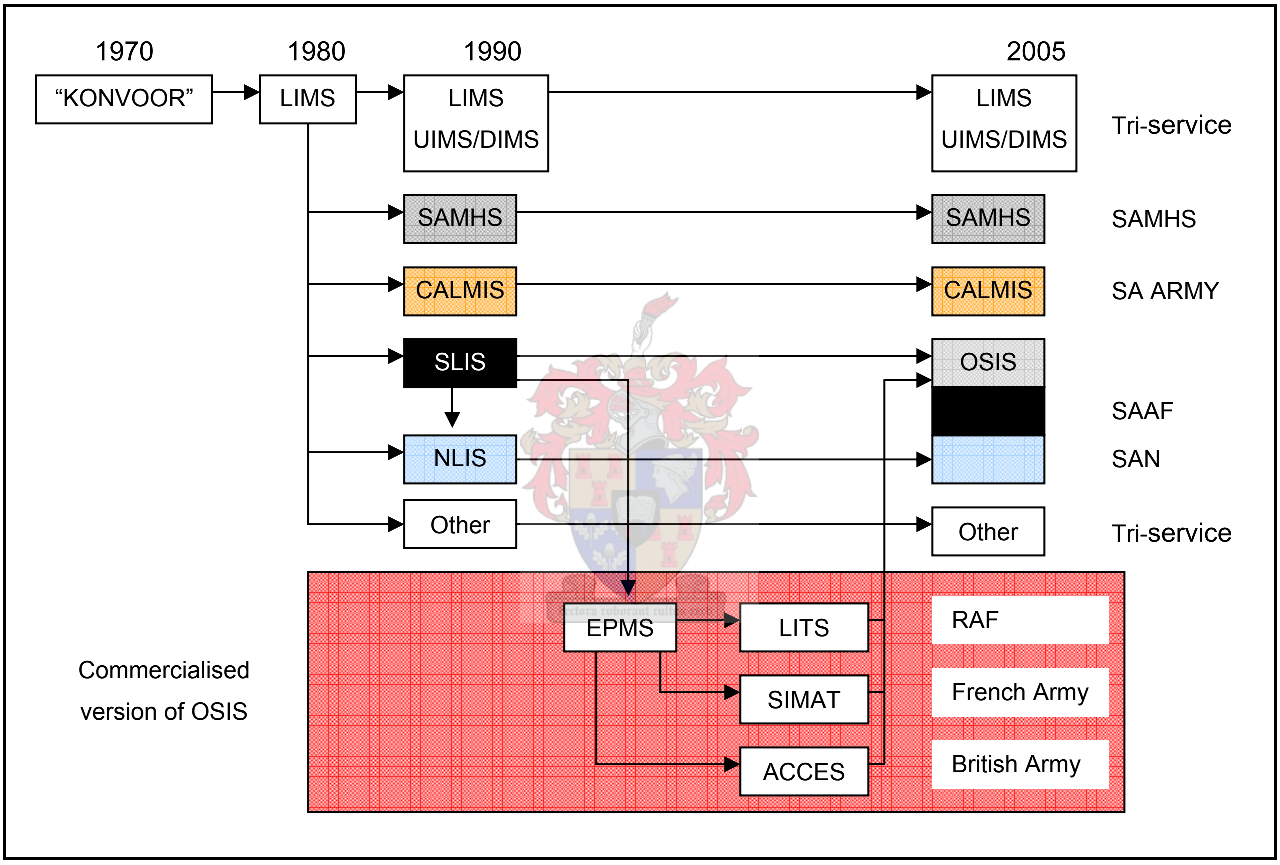

Figure 3.1: Logistical information systems history in the DoD (Bouwman, 2005)

SLIS and NLIS were rewritten between July 1997 and January 1999, and a new version, the OSIS, was released for implementation by December 1999 for the SAAF and SAN. (The name change from SLIS to OSIS will be explained in Section 3.3.) The rewrite was based on an agreement that SITA may use the source code of the EPMS product that was in use by the UK RAF and the French Army. OSIS is still under implementation at SAAF and SAN units (Bouwman, 2005b).

As the implementation of CALMIS and OSIS is still in process, there are units and service divisions that still use the old mainframe-based system. Figure 3.1 illustrates the use of the different systems.

Because of their perceived high costs and overlapping functionality, these logistical information systems were the subject of debate for several years. It has become increasingly difficult to justify the existence of three logistical systems (LIMS, CALMIS and OSIS). This redundancy has accumulated enormous costs in all areas over the years.

In 1998, the Defence Staff Council initiated a study with regard to the standardisation/rationalisation of the current systems (Bouwman, 2005a). Currently, discussions are being held between the four arms of service to standardise the whole defence force's logistical systems. Talks thus far indicate that a system based on the foundation of OSIS is being looked at as the standardised logistical system for the DoD (Marais, 2005).

3.3 DETAILED BACKGROUND OF OSIS

During 1980, the SAAF requested a master plan to direct the development of the SAAF logistical function. This led to the establishment of the LSMP3 (logistical system master plan), which was published in 1993. One of the elements of the LSMP3 was the development and implementation of the SAAF logistical information system (SLIS). The SLIS programme was to run concurrent and interactive with the LSMP3 programme (Bouwman, 2002).

The SAAF contracted Paradigm System Technology to build SLIS (Bouwman, 2005). Implementation of SLIS, in a beta test environment was initially restricted to the Oryx helicopter fleet for SLIS Version 2.x and 3.0. Implementation was later extended to the Astra trainer aircraft fleet as part of the aircraft acquisition programme. A vehicle management module was also added to SLIS and implemented at selected sites in the SAAF and SAN. The SLIS version 3.1 was completed with beta qualification achieved during 1997 (Bouwman, 2002).

During November 1996, the Chief of Logistics issued a revised mandate with regard to the further development and implementation of SLIS as part of a stabilisation and risk reduction programme (Bouwman, 2002). SLIS was initially programmed in the ASSYST programming language, which is a locally developed language (Bouwman, 2005b). It was difficult and costly to maintain and develop the language and the application. This led to the development of SLIS 3.1, an "ASSYST-free" (AF) version, which was then programmed in UNIFACE (a fourth generation, internationally recognised programming language). The further development of SLIS also showed that it is possible to use one IS for more than one Arms of Service (the SAAF and SAN) by configuring the business rules manually and by not programming it into the application. In this case, SLIS is not just a logistical IS but it also supports operations (Bouwman, 2005b). This has led to the name change from SLIS 3.1 "ASSYST-free" to OSIS in 1997 (Bouwman, 2002).

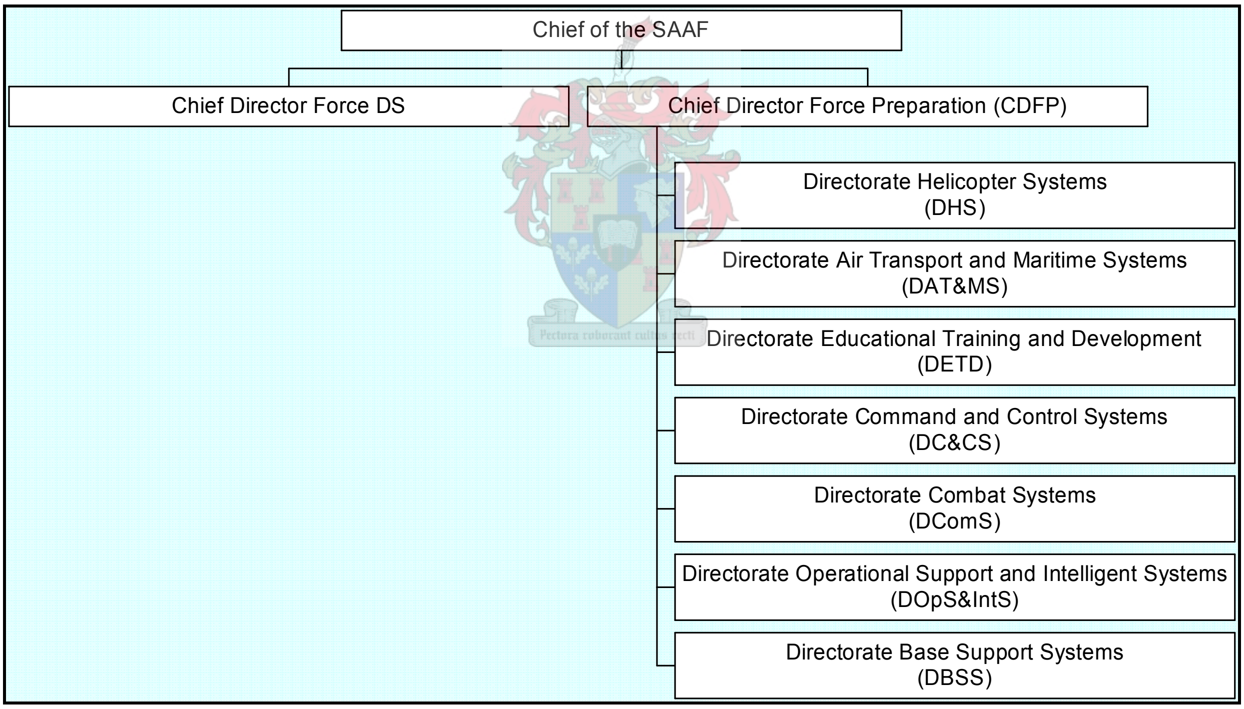

Figure 3.2: OSIS operating environment in the SAAF (Marais, 2005)

In 1998, the source code for OSIS was transferred from Paradigm Systems Technology to the DoD. With the creation of SITA, OSIS was to be transferred to SITA. Due to the delays in the asset transfers, the product owner responsibility and intellectual property rights of the OSIS product in its current from still reside with the DoD (Bouwman, 2005a).

The OSIS operating environment (Figure 3.2) falls under the CDFP. The directorate comprises seven sub directorates. Each of these seven directorates has a consultant (business advisor) that advises each director on the implementation and use of OSIS. OSIS is currently implemented in four of the seven directorates. The OSIS implementation process is most complete in the DComS and DAT&MS, followed by the DHS and DETD. Central Flying School Langebaan Road (under the DETD) is the first Air Force base where the vehicle management module and the logistical components (buildings, furniture, equipment etc.) have been migrated to OSIS (Rossouw, 2005).

3.4 MISSION OF OSIS

The primary mission of OSIS is to be an integrated, cost-effective and reliable computerised operational support information system to the SAAF. The focus is to support the functional areas of operation management, configuration management, material management, maintenance management, configuration management at transactional, managerial and executive level, thus the operating management system (OMS) of the future (Marais, 2004).

3.5 FUNCTIONAL OVERVIEW OF OSIS

The SAAF was investigating ways and means to improve profitability and cost-effectiveness. The management of equipment with regard to performance, maintenance and sufficient pool levels was of the essence to the SAAF. One way of handling this was the development of a logistical information system, which ultimately led to the implementation of OSIS.

OSIS supports the weapon system manager (WSM) to coordinate the SAAF's logistical tasks in order to have sufficient logistical support in the execution of its missions. This is achieved by delivering mission-ready systems to the operational environment based on the SAAF's requirements.

OSIS covers all the functional needs of the SAAF. It is an integrated system for the management and cost-effective optimisation of weapon systems. It includes all the functions related to technical material support and operational planning. OSIS consists of various modules, which have been integrated to support the logistical problem (SLIS 3.1AF User Orientation Material, 1998).

The functional requirements of OSIS, as identified in the development phase, are graphically presented in Figure 3.3 as the twelve different modules OSIS consist of (Roux, 2004). OSIS is functionally segmented into the following modules:

3.5.1 System administration module

This module provides security towards the database in terms of roles and grant of user access by verifying access rights (Marais, 2004).

3.5.2 Acquisition (ACQ) module

The purpose of this module is to enable the management of acquisition programmes from the acquisition of user systems. This module also enables, where applicable, the management of systems and support improvement programs (South Africa LSMP3, 1993).

3.5.3 Long-range forecasting (LRF) module

This module provides data for business plans, calculated predictions and simulation of future utilisation (Marais, 2004).

3.5.4 II system module

The II system module comprises a central Cobol/mainframe-based system, supporting terminals deployed at most of the SAAF's organisational sites. The II system module is used for material item management configuration between units that still utilise the mainframe system, LIMS, and units that utilise OSIS (Bouwman, 2002).

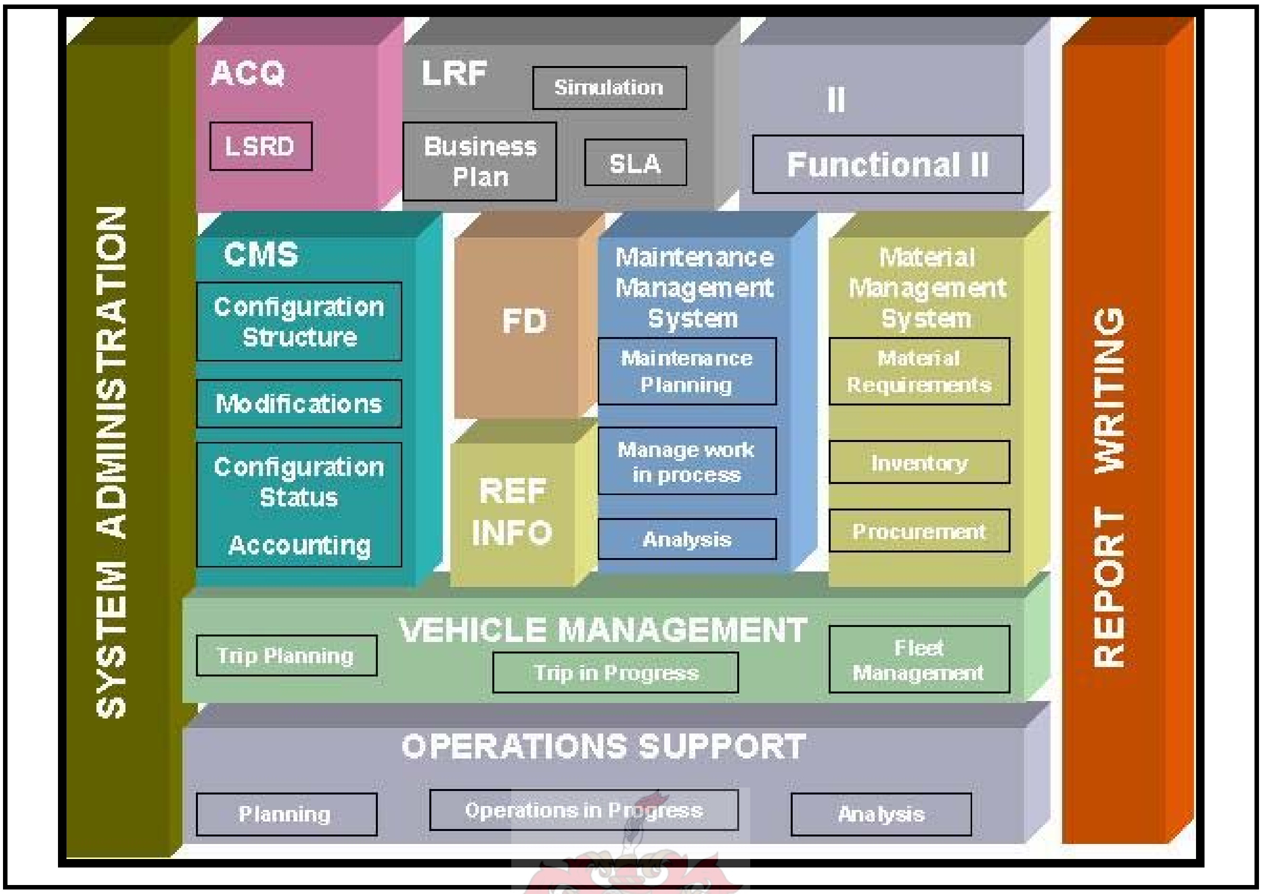

Figure 3.3: OSIS modules (Roux, 2004)

3.5.5 Configuration management (CMS) module

This module focuses on the information of the various components that together form a complete weapon system. Information pertaining to specific product manufacturer, serial numbers, part numbers and so forth is managed to ensure that parts that are replaced are not substituted incorrectly and that the weapon system operates according to predefined parameters, airworthiness rules and baselines. This module maintains record-keeping (Marais, 2004).

3.5.6 Fault diagnostics (FD) module

This module provides a tool for technical staff to assist with faultfinding on a system making use of fault diagnostic trees and case-based history and is therefore a knowledge-capturing database (Marais, 2004).

3.5.7 Reference information viewer (REF INFO) module

This module provides the ability to view electronic documentation with built-in links to the maintenance management module (Marais, 2004).

3.5.8 Maintenance management module

This module places emphasis on job card management, personnel competencies and maintenance planning. It will manage all functions required to return a system from a repairable to a serviceable state and to keep a system in a serviceable condition (Marais, 2004).

3.5.9 Material management module

This module places focus on the material utilised in the various operation systems. Product quantities, locations and distribution details are readily available and an auditing trail is generated for all products and components resident in a ledger, bin or store (Marais, 2004).

3.5.10 Report-writing module

This module provides the ability to produce reports to all levels of management in the format required. The aircraft log is also produced by means of this module. This is therefore the OSIS output interface (Marais, 2004).

3.5.11 Vehicle management system module

This module focuses on all vehicle fleet management functions similar to the aircraft and ground systems environments. All information pertaining to the management of vehicles is readily available (Marais, 2004).

3.5.12 Operations support module

This module provides the capability to register missions, crew for missions, flying time, crew logbook information and aircraft utilisation with the configuration for missions (Marais, 2004).

3.6 VALUE-ADDING FACTORS INTRODUCED BY OSIS

With the implementation of OSIS, the SAAF's way of doing business has changed dramatically. The value-adding factors below were obtained from the interviewees that work directly with the development and implementation aspects of OSIS. Each of these factors will be quantified into a characteristic of the OSIS-value instrument.

3.6.1 Readiness of SAAF has improved

The "readiness" of the SAAF has improved where OSIS was implemented. Situational reports can now be obtained with a minimum amount of effort, any time of the day, as opposed to only once a day before OSIS. The time to draft these reports is now a fraction of what it used to be. The integrity of the data compiled in these reports is much higher, and can be verified by the directors who have OSIS, containing all the data, on their desktop (Rossouw, 2005).

3.6.2 Performance measurement capability for SAAF

OSIS supports and enables processes, procedures and improvement initiatives. This is achieved through a set of performance indicators contained in the OSIS management reports. These reports have been designed to indicate progress in terms of high-level goals and objectives by reporting performance at various levels of management. Reports contained in OSIS provide visibility in terms of performance, but also supply detailed information to help identify the reasons for poor performance. Management uses this capability to initiate improvements through corrective actions (SLIS 3.1AF User Orientation Material, 1998).

Management (at Headquarters in Pretoria) requires situational reports of the various bases (dispersed over a geographical region) in order to plan, budget and ascertain that optimal performance is achieved. Prior to OSIS, these reports had to be faxed every morning to management. The commanders responsible for drafting these reports might not always have reported on time, or might not even have presented the true situation. With OSIS, management can request real-time reports on any activity (e.g. maintenance levels, how many sorties were flown, aircraft availability, etc.) from any unit (where OSIS is implemented) at any time. As a result, OSIS gives management a transparent managing tool that directly contributes value to the SAAF.

3.6.3 Adherence to logistical elements

OSIS forces the SAAF to follow the logistical elements (e.g. configuration management, training, support, documentation, etc.) due to the fact that these elements were built into the application (Roux, 2005). Some of these logistical elements were very well developed in OSIS, for example, the LIMS only had a maintenance capability, but OSIS has a configuration management, material management and document management capability (De Beer, 2005).

3.6.4 Improved data integrity

With the implementation of OSIS, the SAAF's data integrity has improved immensely. OSIS still have some data-integrity problems, due to software refinement that needs to be done, but periodical data-integrity audits are conducted to sort out these problems (Roux, 2005).

3.6.5 Improved flight safety

Flight safety has improved; it is now much easier (as opposed to the traditional manual effort) to determine the serviceability of an aircraft (Roux, 2005).

3.6.6 Information for decision-making

With OSIS's data storage capability, data is available for statistical analysis that can be used for better strategic decision-making by managers (Roux, 2005).

3.6.7 Improved planning

OSIS gives management the capability to retrieve historical data that can be used for better planning (in case of mission preparation) and for projection (to ensure correct maintenance store pool levels) (Roux, 2005).

3.6.8 Forced adherence to procedures

Due to the decline in competencies and discipline of the users, OSIS forces the users to adhere to procedures. Sometimes users omit to complete a field on the input screen because the required information might not seem important or necessary at that moment. The data, however, might be important in future. The build-in procedural steps in OSIS that have to be followed before a user can advance to the next step/screen/action accomplishes this forced adherence to procedures (Roux, 2005).

3.6.9 Avoid duplication of serial numbers

In the past, it was very difficult to ensure that serial numbers of parts for an aircraft are not duplicated, due to the poor data-sharing capability of the SAAF systems (see Subsection 3.6.10). With OSIS, the system will warn the user if a serial number had already been allocated to a specific aircraft part and will not allow the user to proceed without a unique serial number. This aspect is very important for configuration management (Roux, 2005).

3.6.10 Improved data-sharing capability

OSIS operates on an organisation-wide network that allows bases to share data more effectively. This capability also allows data to be available at any given time (Roux, 2005).

3.6.11 Correct management information of new aircraft

With the acquisition of the new fourth-generation aircraft (e.g. the Grippen), OSIS requires management to ensure that all the management information regarding the new aircraft be sent through to the SAAF. This information regarding the aircrafts' maintenance tasks is needed by OSIS to generate job cards. The information will also help OSIS to capture faults from the aircraft in order to use it in future to do fault diagnostics (Roux, 2005).

3.6.12 Improved configuration management

OSIS has helped weapon system managers (WMS) to keep track of which part is allocated to which aircraft. The Oryx helicopter, for example, has approximately 30 000 parts that have to be configured. The configuration management capability of OSIS allows WMS to do this easily.

3.6.13 Immediate visibility

OSIS has an active reporting capability that ensures management has immediate visibility at all units where OSIS has been installed. If a report regarding a specific aspect at a specific unit is requested, management now have the capability to recall that information from its desktop, without the need to inform or contact that unit. For example, management (in Pretoria) might want to know the following: The number of hours flown in, for example March 2005, at the training unit Central Flying School Langebaan Road (Western Cape). This can easily be recalled by using OSIS (Roux, 2005).

3.6.14 Improved capability management

OSIS is continually under development. Currently (March 2005), 90% of the data elements are in place to provide OSIS users with a capability management module. This module will allow management to assess what the SAAF capabilities are. For example, the system (by using historical data) can determine what capability is necessary for rapid force deployment, and following that, the system can ascertain what the current capability of the SAAF is. This is important with regard to the training of pilots (fighter pilots, transport pilots, and helicopter pilots), acquisition of fuel, missiles and bombs. All this information is now integrated into one system: OSIS (Roux, 2005).

3.6.15 Management of personnel competencies

Only qualified personnel are allowed to repair and maintain aircraft. OSIS automatically issues job cards when work needs to be done on a specific aircraft. Job cards will only be issued to personnel with the correct (applicable) and valid competencies (a competency can expire). This capability will enhance the flight safety capability as discussed in Subsection 3.6.5 (Roux, 2005).

3.6.16 Capability to verify data on different organisational levels

OSIS has the capability to verify data on different organisational levels (see Figure 3.4). It can verify on Level 1 (Organisational Level 1 and 2) how many of which type of missions have been conducted. On Level 2, it verifies the specific reference data pertaining to every aircraft. On Level 3 (Organisational Level 4), it uses the data from the top two levels as rules to capture data from the users of the system (Roux, 2005).

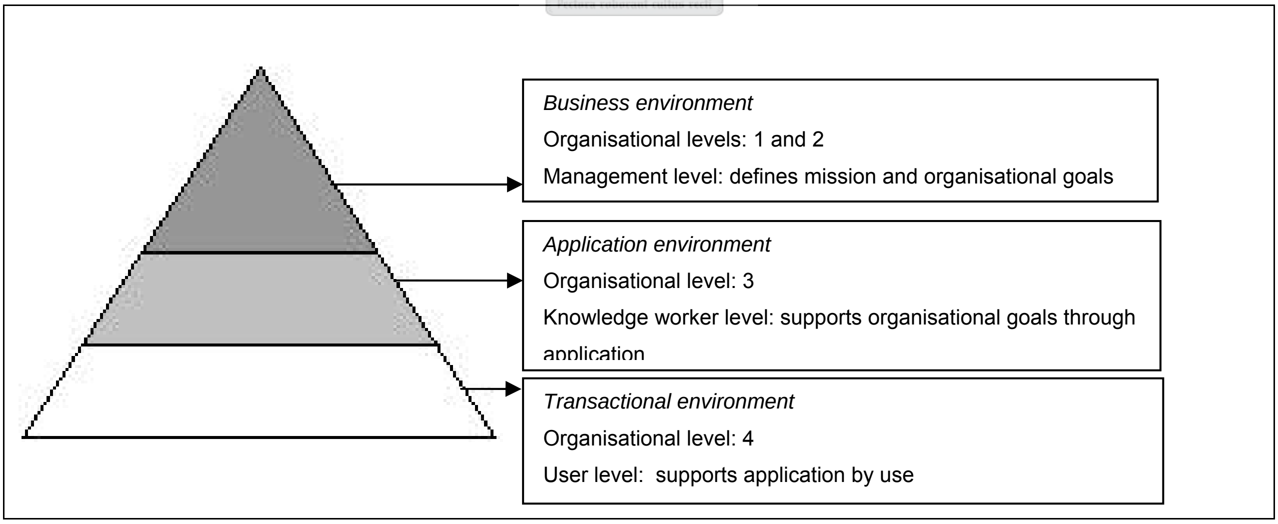

Figure 3.4: Organisational hierarchy of the SAAF (Greyling, 2005)

3.7 NEGATIVE FACTORS ASSOCIATED WITH OSIS

Having given the positive disposition towards OSIS in the previous section, it is important to also highlight the negative aspects associated with OSIS in order to provide a balanced view.

Negative factors associated with the introduction of IT into an organisation often have to do with the workers' fear of job elimination (Turban *et al.,* 2005). However, in the SAAF, the users of OSIS do not have to be concerned about job elimination due to the bureaucracy of the organisation, but might rather experience resistance to change and to accept the introduction of IT. Some of the negative aspects associated with the introduction of OSIS are discussed in the subsections below.

3.7.1 Tasks take longer

Due to IT infrastructure restrictions at some of the Air Force's bases that has nothing to do with OSIS (for example bandwidth and server downtime), users perceive that work was done faster prior to OSIS (De Wet, 2004).

3.7.2 Lack of expertise in the SAAF

OSIS expertise does not lie within the SAAF, and the SAAF is consequently dependent on consultants contracted by SITA from outside the SAAF (Marais, 2004). These consultants, who are responsible for the development and implementation of OSIS, might not always understand the business rules of the organisation, which might have an impact on the suitability of OSIS to fulfil the SAAF's needs.

3.7.3 Untrained users

A number of OSIS-related problems are caused by the inability of the users to use the system. Untrained users are responsible for these problems (Cook, 2004). Training of users is outsourced to consultants, bringing about discrepancies in the quality and effectiveness of the training.

3.7.4 Business rules are not in place

The periodical change in top-level management results in directors who are not knowledgeable about their area of responsibility (Marais, 2004). As can be seen in Figure 3.2, there are seven different directors in the OSIS operating environment. Only the director of combat systems has remained the same over the past few years. This fact influences the directors' abilities to determine their directorate's needs, which should be fulfilled through the implementation of OSIS.

3.7.5 Ignorance of users

Sometimes users do not understand OSIS's ability, the reason for certain data (Cook, 2004). This result in incorrect/incomplete output, which might place OSIS in a negative light with top-level managers if they do not understand the initial problem: the users' ignorance.

From the above discussion, it is evident that the negative views of OSIS are as important as the positive views when determining the characteristics of the OSIS-value instrument. These negative aspects, similar to the positive aspects, should be quantified and should be included in the OSIS-value instrument. The negative aspects that should be addressed by the OSIS-value instrument are summarised in Table 3.1 below.

Table 3.1: Aspects that should be addressed by the OSIS-value instrument

- The SAAF's ability to ensure that a sufficient IT infrastructure is in place to allow OSIS to operate in an optimum environment.
- The quality of service rendered to the SAAF by the outside contractors.
- Training of the users.
- Involvement/understanding of the top-level managers of OSIS.
- The users' understanding of the capabilities and objectives of OSIS.

3.8 MEASURING THE VALUE CONTRIBUTION OF OSIS

Roux (2005) proposed that, in order to measure the value contributed by OSIS towards the SAAF, the benefits of OSIS as described in Section 3.6, and the negative aspects described in the previous section, should be quantified. In order to accomplish that, it was proposed during the group discussions with the RAF and the business advisors that an attempt should be made to quantify the key performance indicators of the organisation before and after the implementation of OSIS. Greyling (2005) elaborated that it is important to distinguish between what is of critical importance towards the core business of the SAAF and what is superfluous.

3.9 CONCLUSION

This chapter attempted to provide an objective overview of the background, development and implementation of OSIS. The second part focused on the characteristics of OSIS (positive and negative aspects), which might have an influence on the development of the OSIS-value instrument. The latter part was accomplished the latter part by considering the value-contributing aspects of, and negative aspects associated with OSIS to the SAAF, as perceived by the business advisors and users of OSIS.

OSIS is not merely a logistical information system; it is a multilevel information system supporting the SAAF on all organisational levels. It was specifically developed according to the SAAF's requirements. The development of OSIS has not only had an immense impact on the SAAF and consequently on the Department of Defence, but it also had an impact on the wider industry. Three other arms of service, the Royal Air Force, the British Army and the French Army, have bought the commercialised version of OSIS, thereby confirming the possibilities of the system.

It is difficult (as will be seen in Chapter 4) to measure the success of an information system, as it is easy to get fixated on the costs of the development, implementation and maintenance of such a system. It is important to note that the introduction of an information system does not automatically guarantee obvious benefits to the organisation. Several of the problems that are being experienced by the organisational stakeholders after the implementation of OSIS have nothing to do with the architecture, reliability or integrity of system, but are rather created as a result of the inability of the environment to accommodate the system in order to ensure optimal performance.

CHAPTER 4

OVERVIEW OF INSTRUMENTS/MODELS FOR THE SUMMATIVE EVALUATION OF INFORMATION SYSTEMS

4.1 INTRODUCTION

Too many information system projects are initiated without a clear statement of what will be regarded as a successful system or what value that system will add to the firm. A distinction should be made between the success of an IS and the value an IS adds to a firm.

Wateridge (1998) conducted a study to determine how success can be defined in order to determine a way to measure the success of IS projects. The important aspect highlighted by his study was that the success of an IS project may be judged from different viewpoints. Due to the diverse types of stakeholders in such a project, success can be defined in numerous ways.

Whyte *et al.* (1997) conducted a similar study, using the repertory grid technique, and identified success criteria, as perceived by the users of the system. Because of the dynamic IS environment, success criteria should be adaptable, but still accurate. Whyte *et al*. (1997) emphasised that success criteria are left to the users to interpret in their circumstances against their own expectations, which may be concerned with cost savings, improvement of customer service, competitive advantage.

The value of IS to a firm is, to a large extent, intangible and difficult to measure. This inability to measure its contribution implies that it is never reflected on the financial statements of that firm. This has an impact on the faith that investors, stakeholders and firm management have in IS (Tillquist and Rodgers, 2005).

There are diverse sets of measuring instruments available for the summative evaluation of an IS. In this chapter, an attempt will be made to examine some of the instruments and models available to evaluate an IS and to measure the value an IS adds to a firm.

4.2 MEASURES FOR THE SUMMATIVE EVALUATION OF INFORMATION SYSTEMS

"Software is a tool. It is configurable," said Chakib Bouhdary, vice president, value engineering, at SAP America. "It all comes down to how it is being used and how you measure its value. We have seen the same software being used by two companies in the same industry. Some use it to their advantage. Some make a mess of it" (Information Technology Value Creator or Commodity, 2004). Considerable thought has to be given to system implementation and the system operating environment when developing an instrument to measure the value OSIS adds to the SAAF.

Companies often invest in IT out of strategic necessity. However, the investment in IT alone is seldom sufficient to guarantee continued business performance (Marchand, Kettinger and Rollins, 2001a). In the following two sections, measures for the summative evaluation of an IS will be examined. In the first section, eight measuring instruments will be discussed. Two of the eight instruments will be classified under User Information Satisfaction instruments; the rest will be discussed individually. In the second section, four summative measuring models will be discussed.

4.2.1 User satisfaction instruments

Saarinen (1996) states that the traditional evaluation of IS success, which is based on criteria such as return on investment (ROI), payback period and net percent value (NPV), is seldom sufficient and should be supplemented by subjective judgement and surrogate measures. One possible measure is that of user satisfaction. Various sources (see Goodhue *et al.*, 2000; Doll and Weidong, 1994; Ives *et al.,* 1983) have argued that measuring satisfaction of users is useful as a surrogate measure of IS success. The application of user satisfaction in measuring information system success is common among IS researchers and a number of standardised instruments have been developed and validated (e.g. Ives *et al.,* 1983). The application of user satisfaction for measuring the perceived IS success is discussed in the sub-sections below.

4.2.1.1 The user information satisfaction instrument

The **user information satisfaction** (UIS) instrument was developed by Cyert and March (Ives *et al.,* 1983), who suggested that an information system, which meets the users' needs, would underpin satisfaction with that system. UIS is a perceptual measure of systems success and serves as a substitute for objective determinants of IS effectiveness, which are frequently not available. Bailey and Pearson's IS success (ISS) model has received most attention with their identification of 39 factors that influence a user's IS satisfaction (Li, 1997). They defined user satisfaction as "The sum of one's positive and negative reactions to a set of factors affecting the success of an IS". This instrument focuses on nine characteristics of information quality, namely:

- accuracy;
- precision;
- currency;
- output timelines;
- reliability
- completeness;
- conciseness;
- format; and
- relevance.

These characteristics are appropriate to the case of OSIS. Output timeliness was one of the complaints from the users when asked about their perception of OSIS. Ives *et al.* *(*1983) refined Bailey and Pearson's study and reduced the number of factors from 39 to 13; and rephrased the definition of UIS to: "The extent of the users' belief in the efficacy of the IS available to them in meeting their information requirements" (Saarinen, 1996).

There was no consensus regarding the validity of UIS as an indicator of IS success. DeLone and McLean (cited in Somers, Nelson and Karimi, 2003) identified three reasons why UIS has been used as a measure of IS success:

- high degree of face validity;
- development of reliable tools for measure; and
- the conceptual weakness and unavailability of other measures.

Saarinen (1996) cited many authors opposing UIS as a valid measurement of IS success. Their problems with the instrument were:

- UIS is not grounded in theory and there is uncertainty whether it covers all the important features of IS success;
- the items in the existing measuring scales are heterogeneous;
- UIS does not take the modern IS environment into account; and
- measuring scales use adjectives such as “very well”, “adequate”, “marginal” and “poor”, thereby converting the scales into interval scales.

DeLone and McLean (1992) later showed that the UIS does not take the individual or the organisational impacts into account. The organisational impact of OSIS is important to this study, and because the UIS instrument lacks in that regard, UIS will not be appropriate to be used on its own as the OSIS-value instrument.

Saarinen (1996) cited DeLone and McLean who maintained that the success of an IS is a multidimensional concept and who developed the **extensions of UIS** model with the following four dimensions:

- satisfaction with the system development process;
- satisfaction with system use;
- satisfaction with system quality; and
- the impact of IS on the organisation (benefits of the investment).

4.2.1.2 End-user computing satisfaction instrument

Doll and Weidong (1994) developed a 12-item instrument, which is based on the foundations of the UIS instrument of Ives *et al.* (1983) to measure end-user computing satisfaction (EUCS). End-user satisfaction is "the affective attitude towards a specific computer application by someone who interacts with the application directly" (Doll and Torkzadeh, 1988). Their study distinguishes between "user information satisfaction" and "end-user's satisfaction with a specific application". The former is associated with the satisfaction with normal data processing applications neglecting the needs of a specific application such as "ease of use" included in the latter. Decision-makers work directly with the application software, manipulating data to obtain the necessary information. Initially, after reviewing the works of peers on the subject of end-user computing, a 40-item instrument was compiled. This 40-item instrument was used in a pilot study of five firms after which the items were reduced to12 after eliminating items for low correlation and duplication (Doll and Torkzadeh, 1988).

EUCS can be used as an assessable substitute for utility decision-making. It is a single second-order, multifaceted construct consisting of five subscales: content, accuracy, format, ease of use and timeliness. This instrument has been used successfully in a number of studies (see Somers *et al.,* 2003) and is regarded as comprehensive (Xiao and Dasgupta, 2002). However, the EUCS instrument has also been criticised in literature due to the fact that IS used in practice is not always voluntary (Au, Ngai, and Gheng, 2002) and the EUCS instrument only mentions "user satisfaction" once in the 12-item questionnaire (Xiao and Dasgupta, 2002).

Even though the EUCS instrument has been widely used and is successfully applied, it will not be very successful in the OSIS operating environment. The focus of the EUCS instrument just like the UIS instrument, is based on the perceptions of the users of the system. In the case of OSIS, the user may not give the true reflection of the value contributed to the SAAF by OSIS, as his/her perception of what OSIS really entails may be distorted. Thus, even though some characteristics of the EUCS instrument are appropriate in the case of OSIS, it cannot be used on its own as the OSIS-value instrument.

4.2.2 Servqual

Jiang and Klein (1999) define service quality as "the match between users' expectation and actual IS service provided". The initial Servqual instrument developed by Parasuraman, Zeithami and Berry was a 22-item instrument consisting of five dimensions, namely *tangibles, reliability, responsiveness, assurance* and *empathy.* This instrument measured service quality over a broad spectrum in organisations (Kettinger and Lee, 1997).

Kettinger and Lee (1997) proposed to use the Servqual instrument to measure IS perceptions and expectations. This led to the development of the 13-item IS Servqual instrument consisting of four dimensions, namely *reliability, responsiveness, assurance* and *empathy.* This variation of the instrument has been criticised by Van Dyke, Kappelman and Prybutok (cited in Kettinger and Lee, 1997) who questioned the service quality gap measurement approach and its legality in the IS field. These concerns were addressed by Kettinger and Lee who stated that "The service quality measures as adapted for the IS environment should not be discarded until sufficient evidence has been produced conceptually and empirically" (Pather, Remenyi, and Erwin, 2003).

Kettinger and Lee (1997) developed the Servqual as the instrument with the greatest potential as an IS service quality diagnostics tool. This instrument can also be used within two (minimum and desired service level) or within three dimensions (minimum service, desired service and perception of service). The latter dimension is known as the Servqual+ version. Service quality is important to the SAAF as the services rendered to the OSIS users are in the majority of cases rendered by consultants contracted from outside the SAAF.

These contracted personnel have a service level agreement with the SAAF to render certain services that include the training of end-users. If this agreement is not honoured (that is if the quality of the service rendered is unacceptable), the results and ultimately the value of OSIS, may be affected.

4.2.3 Management information system (MIS)/decision support system (DSS) success measure

The MIS/DSS success measure was developed by Sanders (1984) as an instrument to measure several aspects of system success. His research was based on prior studies that indicated the value of using surrogates, such as profitability, user satisfaction and the widespread use of a system, for evaluating system success.

However, the MIS/DSS success measure does not attempt to measure system success in terms of the surrogates suggested above. It does however, concentrate on measuring the ability of a DSS to support decision-making and to contribute to the user's overall satisfaction. Ultimately, the instrument also has the tendency to enhance organisational effectiveness, since a definite link has been identified between organisational goal achievement and the quality of individual decision-making (Sanders, 1984).

One of the primary instruments used in the study by Sanders (1984) was the 40-item multidimensional perceptual measure of DSS success developed in the early 1980s by Welsch (cited in Sanders, 1984). The Welsch scale consisted of six separate dimensions of the DSS success construct. The dimensions identified were:

- support for DSS;
- reliance on DSS;
- extent of usage;
- improved decision making;
- effectiveness of DSS; and
- usefulness of DSS.

Due to a number of drawbacks with this instrument only 17 out of the 40 items were used in Sanders' (1984) study. Three items were added from the studies by Schultz and Slevin (cited in Sander, 1984) and Ginzberg (cited in Sanders, 1984). This formed Sander's 20-item instrument.

After principal common factor analysis was performed on the 20 items, it produced a two-dimensional DSS success measure. The first dimension, containing seven items is an indicator of improved decision-making or decision-making satisfaction. This will be appropriate in the case of OSIS, as it will be an indicator of the use of OSIS by senior managers. The second dimension, which has thirteen items, is a measure for overall system success. These thirteen items relate imaginatively to aspects of the system, which, in a general way, lead to the successful performance of the user's job, though not necessarily in the context of decision-making.

The two dimensions of this instrument concentrate on those properties of a computer system that measure the ability of a system to assist in decision-making and the contribution of a system to better job performance. It does however not include aspects such as the ability to measure the system's (OSIS) quality, such as speed and accuracy.

4.2.3 Information orientation

Marchand *et al.* (2001a) developed a metric, Information Orientation (IO), which measures the extent to which senior managers perceive their organisation to possess the capabilities associated with effective information use to improve business performance. This metric was developed based on survey results of 1 009 managers. It incorporates the interaction of people, information and technology. The study has showed that there was little interaction between these three entities in the past. The development of this metric shifted the focus away from financial management towards softer issues, for example, how people interact with information and how IT can be used to facilitate the use of information within the business environment.

The IO comprises three information capabilities (IC) associated with effective information use, namely: **information technology practices (ITP)**, **information management practices** and **information behaviours/values**. Each capability was empirically validated to form the confirmatory model. It was evident from the study that being good at only one capability is advantageous but insufficient to improve business performance. IC in all three domains is necessary for optimal performance improvement.

Each IC has lower level dimensions (competencies) that consist of a number of factors (see Appendix A). These factors form the survey questions, measured on a Likert scale from one to seven. This forms the confirmatory factor model of information orientation (see Figure 4.1 below).

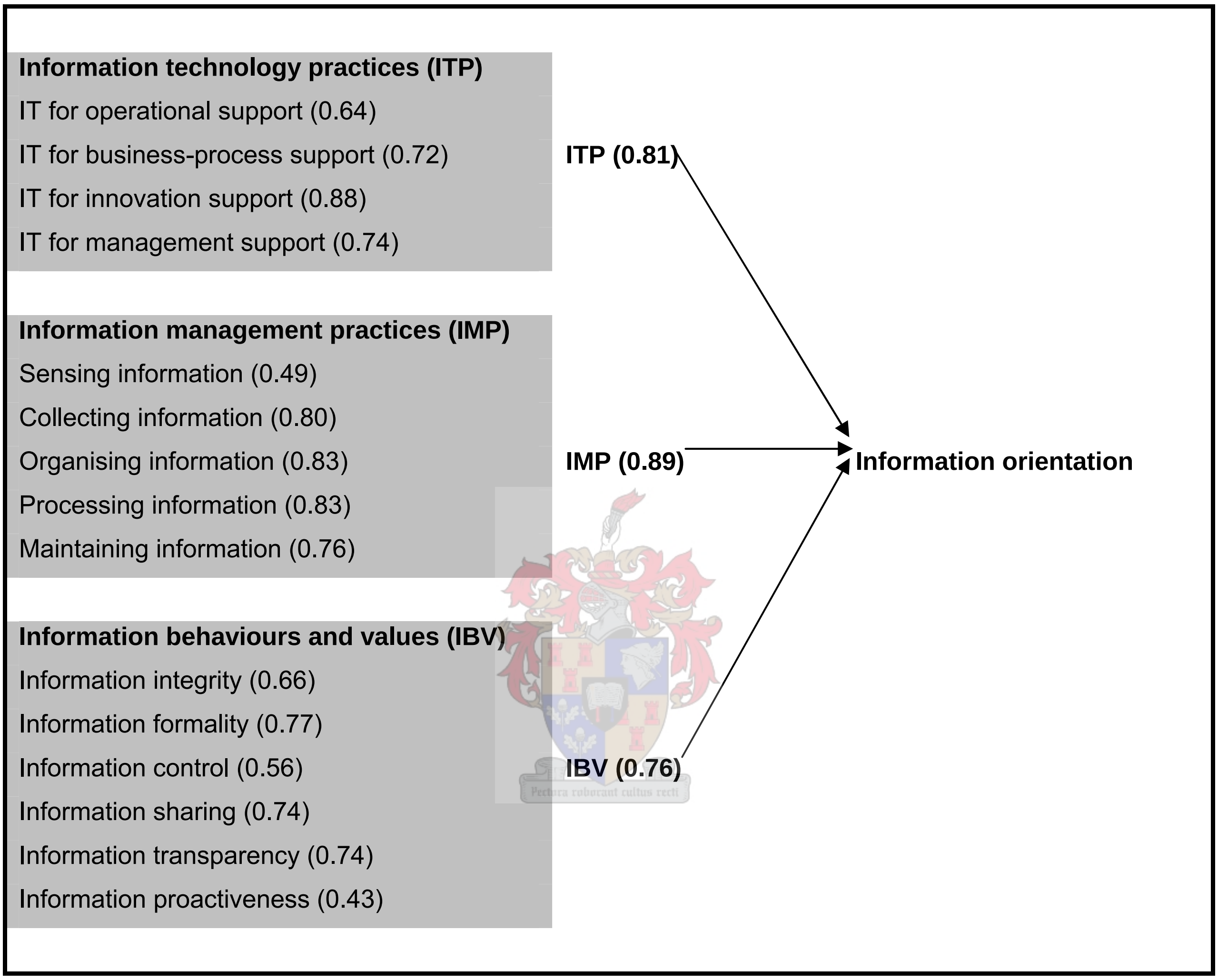

Figure 4.1: Confirmatory factor model of information orientation (Marchand *et al.*, 2001a)

With the IO metric, one can measure how managers view effective information use, but it is not a final measure of overall business performance. Marchand *et al.* (2001a) furthered their study to see how a business's information use affects business performance. Business performance (see Figure 4.2) is measured using multiple criteria, similar to the BSC (Kaplan and Norton, 1999) and not just the traditional financial performance measurement. It was shown in the study of Marchand *et al.*

(2001a) that the relationship between IO and business performance implies: "Effective information use does lead to better business performance but the link is through IO".

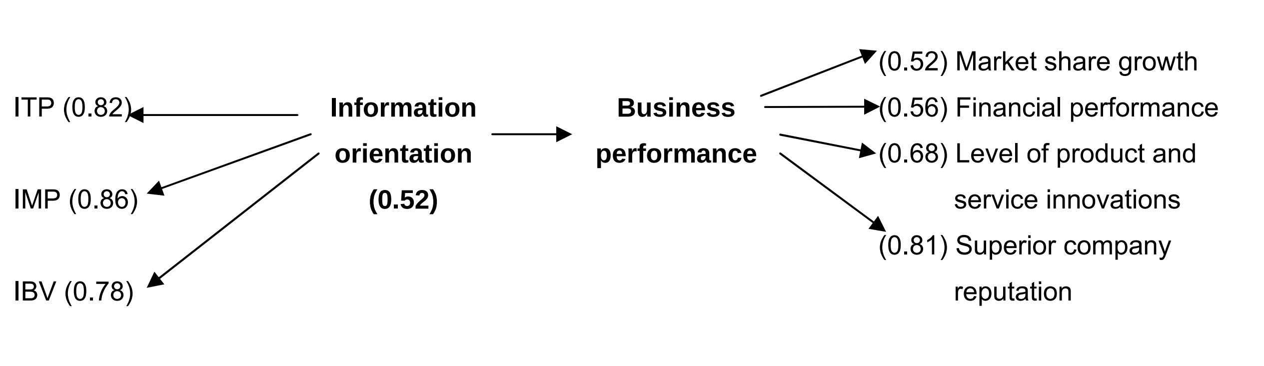

Figure 4.2: Co-alignment model: Information orientation predicting business performance (Marchand *et al.,* 2001a)

The development of the IO dashboard followed. It is an indicative instrument allowing senior managers to assess each IC in their companies. The IO dashboard can be used to show managers where their companies stand in using information successfully and which information capability needs to be improved in order to gain higher IO, which will result in higher business performance gains.

This instrument will be very appropriate in the case of OSIS when it is adapted to be applied to a non-profitable organisation. When applied, this instrument will show how effectively management use the information generated by OSIS, which they can apply to improve their business performance. The IO will also serve as a diagnostic tool that will guide management to where the problem areas in the organisation that need improvement are. One problem with this metric is that it is usually conducted at management level (Figure 5.1). The management level of the SAAF changes often, and the knowledge and expertise of the managers, currently in that position, might not be sufficient to do this instrument justice and this will consequently not be a true reflection of what is going on in the SAAF.

4.2.4 Tobin’s q

This instrument compares, through a ratio, the market value of the firm to the replacement cost of its total assets. If the ratio is significantly more than one, the firm shows a strong return on investment. If the replacement cost of a company’s assets is lower than its market value, then the company is getting monopoly revenues, or higher than normal return on its investment (Bouteiller, 2002).

The advantage of using Tobin's *q* is that the difficult problem of estimating either rates of return or marginal costs is avoided. On the other hand, for *q* to be meaningful, one needs accurate measures of both the market value and the replacement cost of a firm's assets.

It is usually possible to get an accurate estimate for the market value of a firm's assets by summing up the values of the securities that a firm has issued, such as stocks and bonds. It is much more difficult to obtain an estimate of the replacement costs of its assets, unless markets for used equipment exist. Moreover, expenditures on advertising and research and development create intangible assets that may be hard to value. Typically, researchers who construct Tobin's *q* ignore the replacement costs of these intangible assets in their calculations. For that reason, *q* typically exceeds 1. Accordingly, it can be misleading to use *q* as a measure of market power without further adjustment (Carlton and Perloff, 2004).

This approach will not be very effective for the case of OSIS. It is difficult to quantify the most important aspects of OSIS, which is the intangible asset. The benefits (see Chapter 3) of OSIS are almost all intangible. Without the quantification of the intangible assets, the instrument would be inaccurate.

4.2.5 Balanced IS scorecard

The question for whether the investment in IS and IT were really worthwhile prompted Martinsons *et al.* (1999) to propose a balanced IS scorecard. The balanced IS scorecard was based on the traditional balanced scorecard (BSC) developed by Robert Kaplan and David Norton, which was a means to evaluate corporate performance

(Kaplan and Norton*,* 1999). The balanced IS scorecard evaluates an IS from the following four different perspectives:

- internal process perspective;
- business value perspective;
- user orientation perspective; and
- future readiness perspective.

A summary of the four different perspectives in a balanced IS scorecard can be seen in Table 4.1 below.

The balanced IS scorecard is used to obtain efficiency and effectiveness of the IS development process and the use of the IS within an organisation. The balanced IS scorecard is developed based on the principles that IT is an essential internal support function within an organisation (Hassan and Tibbits*,* 2000). Hassan and Tibbits (2000) later adapted this instrument for an electronic commerce environment. The traditional BSC was designed for profitable organisations, but it has been adapted for non-profit organisations. In this variation, the focus shifts from the *financial perspective* toward *customer perspective*.

Although the original BSC has been widely applied (e.g. Kaplan and Norton, 1999) and adopted (Martinsons *et al.,* 1999), the balanced IS scorecard has not received much attention in IS literature in terms of peer review. Based on their own study, Martinsons *et al.* (1999) perceived the following limitations regarding their variation of the BSC:

- failure to include long-term objectives;
- failure to relate key measures to performance drivers; and
- failure to communicate the content and rational for the balanced IS scorecard.

In Hassan and Tibbits's (2000) study to adapt the BSC for electronic commerce, they evaluated the balanced IS scorecard, and concluded that this variation is “insightful” but not “revolutionary”.

Table 4.1: The four perspectives in a balanced IS scorecard (Martinsons *et al.,* 1999)

	Internal processes perspective (operations-based view)	**Business value perspective** (management's view)
Mission:	Delivers IT products and services in an efficient and effective manner.	Contributes to the value of the business.
Key question:	Does the IS department/functional area create, deliver and maintain its products and services in an efficient manner?	Is the IS department/functional area accomplishing its goals and contributing value to the organisation as a whole?
Objectives:	• Anticipates and influences requests from end-users and management. • Is efficient in planning and developing IT applications. • Is efficient in operating and maintaining IT applications. • Is efficient in acquiring and testing new hardware and software. • Provides cost-effective training that satisfies end-users. • Effectively manages IS-related problems that arise.	• Establishes and maintain a good image and reputation with management. • Ensures that IS projects provide business value. • Controls IS costs. • Sells appropriate IS products and services to third parties.
	User orientation perspective (end-user's view)	**Future readiness perspective** (innovation and learning view)
Mission:	Delivers value-adding products and services to end-users.	Delivers continuous improvement and prepares for future challenges.
Key question:	Are the products and services provided by the IS department/functional area fulfilling the needs of the user community?	Is the IS department/functional area improving its products and services, and preparing for potential changes and challenges?
Objectives:	• Establishes and maintains a good image and reputation with end-users. • Exploits IT opportunities. • Establishes good relationships with the user community. • Satisfies end user requirements. • Is perceived as the preferred supplier of IS products and services.	• Anticipates and prepares for IS-related problems that could arise. • Continuously upgrades IS skills through training and development. • Regularly upgrades IT applications portfolio. • Regularly upgrades hardware and software. • Conducts cost-effective research into emerging technologies and their suitability for the business.

The balanced IS scorecard approach will be very applicable to the OSIS case. Even though the balanced IS scorecard has received a lot of criticism, the original balanced scorecard can be adapted to determine the value contribution of OSIS to the SAAF. This approach finds a balance between the financial and non-financial aspects in an organisation, and can be easily adapted for the non-profitable organisations, which makes it perfect for the SAAF, which is a non-profitable organisation.

4.2.6 Asset specificity and asset scope

Tillquist and Rodgers (2005) used asset specificity and asset scope to measure the value of IT. They defined *asset scope* as “the boundaries that include all the elements involved in the value contribution of IT within an organisation” and *asset specificity* as “the specific contribution of IT to each element within those boundaries”. The crux of their study is to differentiate between the value added to a firm through IT alone and the IT isolated from its operating environment.

The contribution of IT to the firm is often scattered, intertwined across many business processes and functions, making it a very difficult task to isolate (Tillquist and Rodgers, 2005). Tillquist and Rodgers (2005) based their studies on the studies of Davern and Kauffman (2000) who defined the concepts of *locus value* and *conversion contingencies*, to investigate what value IT contributes to a firm. Davern and Kauffman’s (2000) study stipulated that: “The return on IT investments include complementary organisational processes such as management skills, user training and application of standards. When one determines the value contribution of IT, one must distinguish between the value added to a firm by the complementary assets and the valued added to a firm by the IT asset. In identifying the IT-specific contribution to the firm, firms must separate the IT contribution to discrete work practices, isolate IT-based impacts on operational and strategic processes, and unbundle the contribution of IT to management decisions.”

Tillquist and Rodgers (2005) utilised the dependency network diagram (DND) methodology, which represents roles, goals, activities and governance controls involved in exchange relations. This methodology was used in context with the realisation that “Value materialises through the relationship between someone with a need and someone with resources to satisfy that need”. The DND prioritises the organisational relationships between activities, entities, and their relationships.

The dependencies placed on an IT system (such as OSIS) should be identified. The consecutive sequence of activities that are initiated as a result of these dependencies, the value-generating activities within the system and the complementary activities required from others may be identified. Activities that the system can perform that were not activated (such as data backup or monitor system performance) are left out during the value calculation.

This instrument is one of the first instruments that specifically measures the IT value contribution to an organisation. It makes value-producing activities explicit, it helps stakeholders to understand how value is created and maximised in the business and it helps in prioritising each activity based on its value, and thus determines where resources should be placed or removed.

By reason of its nature, this instrument might be applicable to the SAAF. However, this approach is complex to apply and requires information regarding each activity of the IS and the dependencies placed on it. Furthermore, this approach only focuses on the system, which is excellent if one is convinced that the system is completely suited to the organisation and the users are competent in using it. As was seen in Chapter 3, the human factor features highly in the OSIS operating environment and should be addressed in the OSIS-value instrument. In addition, this approach is quite new and, as far as could be established, no peer review has been done so far.

4.3 SUMMATIVE INFORMATION SYSTEM SUCCESS MODELS

Measuring models cannot be applied in the same way as an instrument to measure a system. A model is based on theoretical foundations, which usually produce its own set of measuring instruments that is applied in the evaluation process. In the previous section, seven different measuring instruments were examined. In this section, four models used to evaluate IS success, will be discussed.

4.3.1 Key performance indicators

Key performance indicators (KPIs) assist organisations in defining and assessing evolution towards organisational objectives (Reh, 2005). KPIs are organisation-specific (Ramos-Aquino, 2004) and are linked to an already defined organisational strategy, mission and stakeholders (Reh, 2005). KPIs are quantifiable measurements (KPIs can be expressed in percentages, ratios, absolute numbers and others), and can be decided upon in advance, which reflects the critical success factors of an organisation (Reh, 2005).

KPIs are typically used in a post-ante context, meaning they evaluate the past performance of a company (Ramos-Aquino, 2004). Similar to the balanced scorecard, which provided a mechanism to achieve a balance between financial and non-financial aspects, KPIs also incorporate non-financial aspects, which form part of the critical success factors or key performance indicators of a company (Turban *et al.,* 2005).

Table 4.2: Key performance indicators of the SAAF for OSIS

Key performance indicators	Performance parameters					
	Cost		Information integrity		Level of effort for support	
	Before OSIS	After OSIS	Before OSIS	After OSIS	Before OSIS	After OSIS
Readiness	X%	Y%	X%	Y%	X%	Y%
Mission success	X%	Y%	X%	Y%	X%	Y%
Sustainability	X%	Y%	X%	Y%	X%	Y%

One way of modelling the advantages as experienced by the consultants of OSIS is to model it in terms of a key performance indicator (KPI) model. This approach is adaptable regarding organisation and scenario type. It can (depending on the KPIs of the SAAF) incorporate financial issues and (but also important) non-financial issues. The KPI approach is also very easy to implement and does not require any specific knowledge about IT, but only the manager's organisational knowledge. Table 4.2 above illustrates some of the KPIs of the SAAF for OSIS (Rossouw, 2005) that should be defined beforehand. Each KPI is measured by directorate-specific performance parameters. For the current study, the parameters are measured in terms of the parameter's capability before the implementation of OSIS (manually) and what it is now (after the implementation of OSIS). It should be stressed that this measure is perceptual by nature. The model can easily be adapted by specifying new milestones (e.g. OSIS in 2000 versus OSIS in 2005), additional performance measures (e.g. maintenance) and new or additional KPIs (e.g. airworthiness).

4.3.2 The technology acceptance model

Factors influencing the performance gain of a system are often user's acceptance and use of a system. Fowler and Walsh (1999) argued that the usage of a system could only be an indicator of the system's success if it is voluntary. In the case of mandatory usage, user satisfaction may be a good indicator of system success. A major question in Davis' (1989) research was "What cause people to accept or reject information technology?" Two determinants were identified, namely *perceived usefulness* and *perceived ease of use*. Davis (1989) defines perceived usefulness as "the degree to which a person believes that using a particular system would enhance his or her job performance" and perceived ease of use "the degree to which a person believes that using a particular system would be free of effort".

The **technology acceptance model** (TAM) (Bagozzi, Davis and Warshaw, 1992; Davis, 1989) was developed to model the determinants influencing users' decisions regarding the use of new software packages. A validated psychometric questionnaire is used to measure the two determinants (see above). These questions are all answered on a seven-point Likert scale ranging from *extremely likely* to *extremely unlikely*. The measuring instrument of the TAM measures whether the system is useful/worthwhile to the organisation by measuring the system's (OSIS's) perceived usefulness to the user and perceived ease of use.

In the studies conducted by Davis (1989), it was evident that usefulness was significantly more strongly linked to usage than it was to ease of use. Users are driven to adopt an application primarily because of the functions it performs for them and secondarily by reason of how easy or hard it is to get the system to perform those functions. In the case of OSIS, the use of the system is mandatory. Thus, the degree of adoption will not be an indication of system success. However, the attitude with which a user utilises the system will have an effect on the quality of the output.

Although difficulty of use can discourage adoption of an otherwise useful system, no amount of ease of use can compensate for a system that does not perform a useful function.

4.3.3 Task technology fit model

Goodhue *et al.* (2000) criticised the current user evaluation instruments lacking a clear expressed theoretical basis for linking user evaluations with system effectiveness and system performance. Most of the existing user evaluation instruments was based on job satisfaction, and the attitudes and behaviour of the users. They proposed a third theoretical basis, namely **task technology fit** (TTF). TTF indicates that the performance impact of an IS is dependent upon the fit between *technology characteristics*, *task requirements* and *individual abilities*. With this instrument, it is presumed that it is not only technology that affects the performance of a system. When the correct technology is applied to complete a task, better performance is to be expected. Correspondingly, when a user has suitable knowledge to use the technology, better performance is to be expected. The TTF is seen in literature as extending the TAM. In some studies, these two models have been combined, (Klopping and McKinney, 2004) to form one model.

The benefits experienced by the SAAF (see Chapter 3) as a result of the introduction of OSIS are a good indication of the technological characteristics of OSIS. The technological problems experienced by users of OSIS are not always due to OSIS but due to IT infrastructure (see Chapter 3). This instrument might be applicable in the case of OSIS as it is based on the premise that the correct technology (OSIS) will enhance performance (organisational business performance) and that competent users will also ensure better performance.

4.3.4 DeLone and McLean IS success model

In 1992, DeLone and McLean developed the DeLone and McLean IS Success Model (Figure 4.1). This model is based on theoretical and empirical IS research conducted by a number or researchers in the 1970s and 1980s. The model suggested that researchers should "systematically combine individual measures from the IS success categories to create a comprehensive measurement instrument" (Myers, Kappelman and Prybutok, 1997).

This is a multidimensional model, consisting of six interrelated dimensions of success, namely system quality, information quality, system use, user satisfaction, individual impacts and organisational impacts (DeLone *et al.,* 2002).

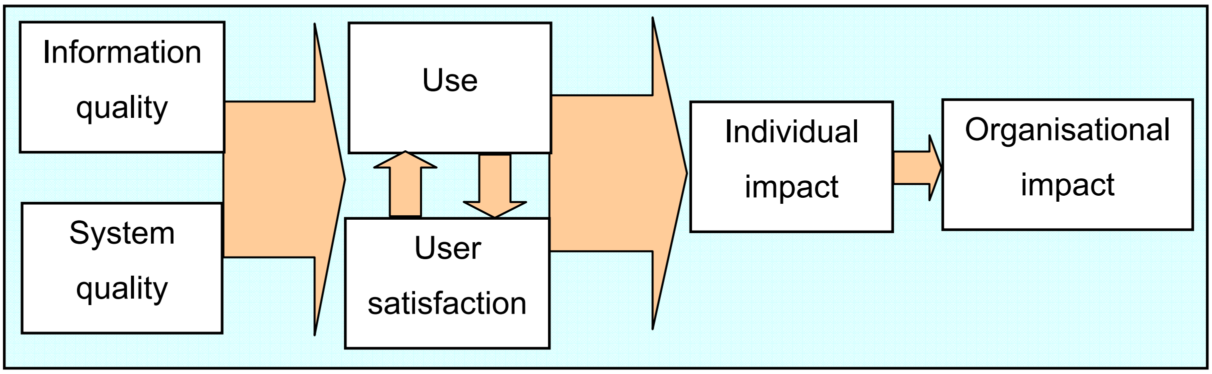

Figure 4.3: DeLone and McLean IS success model (DeLone and McLean, 1992)

A process of understanding of information systems and their impacts drove the creation of the model. The original models, see Figure 4.3, were widely criticised, but supported by a number of researchers as can be seen from the 144 citations of the model in the autumn of 1999 (DeLone and McLean, 2002). It is evident from the model, Figure 4.3, that **system quality** and **information quality** individually and together influence both **use** and **user satisfaction**. Furthermore, the amount of **use** of an IS can affect the scale of **user satisfaction** – positively or negatively – and *vice versa*. **Use** and **user satisfaction** qualify the impact on a user of the system in **individual impact**, which ultimately will have an effect on the organisation in the **organisational impact** (Myers *et al.*, 1997). DeLone and McLean (1992) emphasised that additional research is required to authenticate the model's validity. Seddon and Kiew (cited in DeLone and McLean, 2002), among others, were the first to publish an empirical test of the DeLone and McLean IS success model. This test lead to valuable input into a better understanding of the IS Success dimensions.

DeLone and McLean (2002) used these contributions to reformulate their original IS success model. As can be seen in Figure 4.4, quality now has three dimensions, with the addition of **service quality**. The service quality dimension of the reformulated IS success model was not part of the original DeLone and McLean IS success model, but it was the emergence of end-user computing that prompted researchers to motivate the need for the inclusion of this dimension into the IS success model. Due to the multiple definitions of the behaviour **use** from the original model, **use** is now redefined and can be replaced by **intention to use**, depending on whether the usage of the system is voluntary or mandatory. The original success model had the dimensions of **individual** and **organisational impact**. In the new, reformulated success model (Figure 4.4), these two dimensions have merged into one dimension – **net benefits**. The **net benefits** dimension indicates that an outcome of the evaluation of a system may be either positive or negative on the predefined stakeholder. In the case of OSIS, the company (the SAAF) will be the beneficiary. Nevertheless, regardless of the outcome (positive or negative) the net benefits experienced by the organisation will have an impact on the usage of the system and then ultimately on the user satisfaction with the system and *vice versa*.

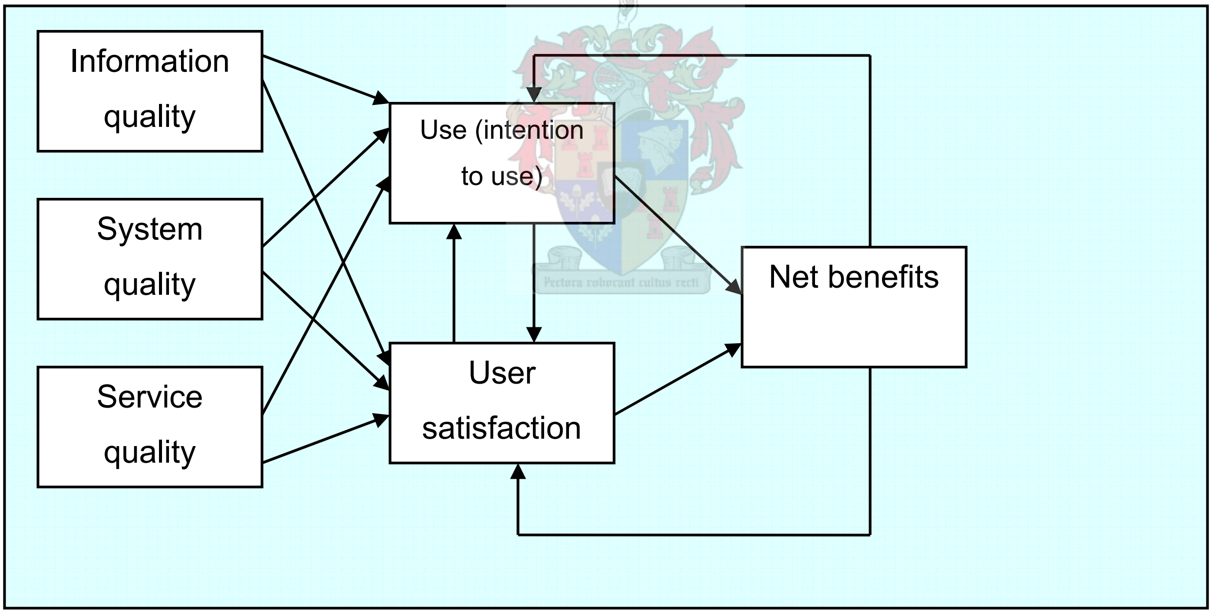

Figure 4.4: The reformulated IS success model (DeLone and McLean, 2002)

DeLone and McLean (2002) stress the importance of a careful definition of each of the dependent variables as depicted in Figure 4.4. When this model is applied to evaluate the success of a system, one should distinguish between the different environments, and on which condition the system being evaluated is used, for example voluntary versus mandatory usage of the system. The model should then be adapted in order to fit the current situation, for example **intention to use** versus **use of system**.

DeLone and McLean's model is easily one of the most influential models, as it has been cited in over 285 refereed journal papers since mid-2002 (DeLone and McLean, 2002). The DeLone and McLean model received criticism from Seddon, Staples, Patnayakuni and Bowtell (1999) who stated that the DeLone and McLean IS Success Model does not clearly state that diverse stakeholders in an organisation may have different conclusions about the success of the same IS.

The DeLone and McLean IS success model includes aspects of all of the above models. It is a well-known and well-cited instrument. It incorporates six measurement levels, the last one being **net benefits** (see Figure 4.4 above), that can be applied in a profitable organisation in terms of monetary values and in a non-profitable environment as a **value-added** dimension to the organisation. This model may serve as a framework to develop an instrument that will measure the extent to which OSIS has added value to the SAAF.

The original and reformulated DeLone and McLean IS Success Model are only models, not measures, but are helpful in the sense that IS success dimensions are provided, which should be measured in order to achieve IS effectiveness. As can be seen from the previous section, these measures of the six IS success dimensions of the DeLone and McLean IS success model is still an issue, which needs attention and which was not addressed by the research of DeLone and McLean. However, DeLone and McLean (1992) advised fellow researchers to obtain suitable measurement instruments to measure each of the six dimensions of IS success.

DeLone and McLean (1992) emphasised the need for additional research for the selection of measures of each IS success dimension. They provided researchers with the following guidance: "The selection of measures should also consider the contingency variables, such as the independent variables being researched; the organisational strategy, structure, size, and environment of the organisation being studied; the technology being employed; and the task and individual characteristics of the system under investigation".

DeLone and McLean (1992) also suggested that the random selection of measures from each of the six dimensions of IS success to form an overall IS success instrument is not recommended. Instead, further research should be conducted by systematically combining individual measures from the IS success dimensions to develop a comprehensive measurement instrument. "It is unlikely that any single, overarching measure of IS success will emerge; and so multiple measures will be necessary, at least in the foreseeable future" (DeLone and McLean, 1992).

4.3.5 Structural equation model (SEM) of IS success

The study by Seddon and Kiew (cited in Seddon, 1997) was based on the framework of the original DeLone and McLean IS success model (as discussed in the section 4.3.4). They supported the model, as it firstly, provides a method for classifying the multitude of IS success measures that have been used in the literature into six categories. Secondly, the original DeLone and McLean Model IS success model suggests “temporal and casual” interdependence between these categories (see Figure 4.1).

Seddon and Kiew (cited in Seddon, 1997) tested part of the DeLone and McLean IS success model. They assumed that the casual model implied by DeLone and McLean’s research was as shown in Figure 4.5 below and therefore tested relationships among the four variables in the dotted-line box. They modified the original model by replacing the **IS use** construct with **IS usefulness**. Their argument for doing so was that, if a system's usage is not mandatory, **use** is a good substitute for **usefulness**. However, when a system's usage is mandatory, the significance of **use** as a measure of a system's effectiveness is weak. Seddon and Kiew (cited in Seddon, 1997) based their definition of **usefulness** on research by Davis (1989) (previously discussed) as "the degree to which a person believes that using a particular system would enhance his or her job performance". A further change included the inclusion of the constructs **importance of the system** and **task/importance** to balance the possibility that systems performing tasks that are more important may be regarded as more useful irrespective of the actual system quality (Armstrong, Fogarty, Dingsdag and Dimbleby, 2005).

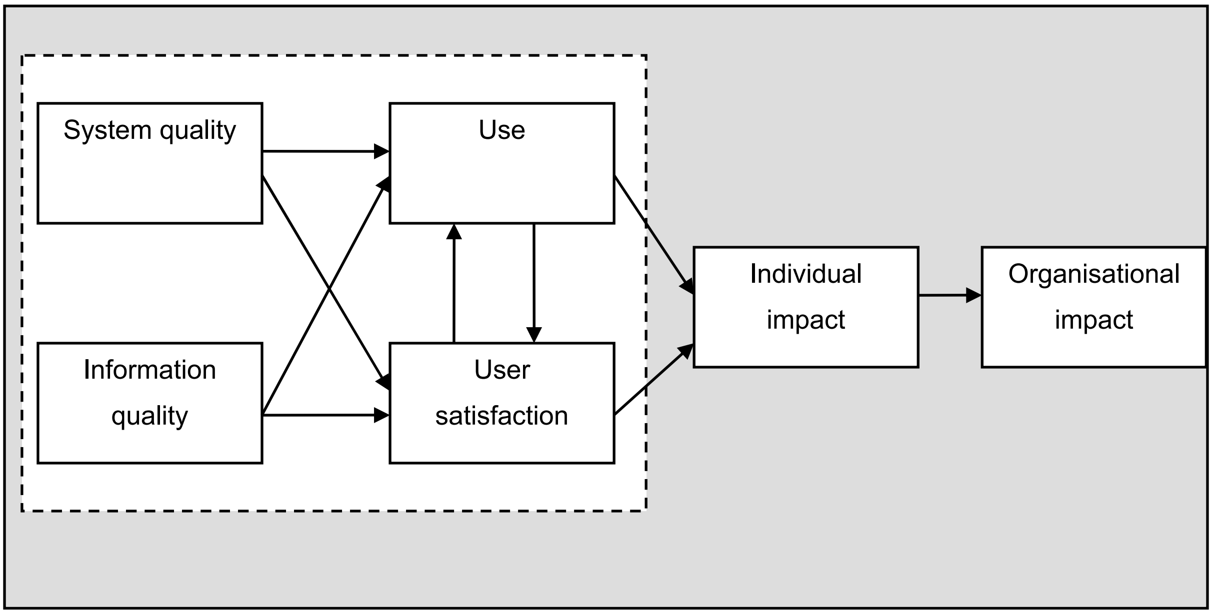

Figure 4.5: Path model implied by DeLone and McLean (Seddon, 1997).

The final research instrument of Seddon and Kiew's study represented a combination of scales from various researchers, namely –

- eight questions on *system quality* from Doll and Torkzadeh (1988) and Davis (1989), plus three additional questions;
- ten questions on *information quality* from Doll and Torkzadeh (1988);
- six questions on *perceived usefulness* from Davis (1989);
- four questions on *user satisfaction* from Seddon and Yip (cited in Armstrong *et al.*, 2005); and
- five questions on *importance of system* from Zaichkowski (cited in Armstrong *et al.,* 2005).

Figure 4.6 shows the interaction of these variables (Armstrong *et al.*, 2005)

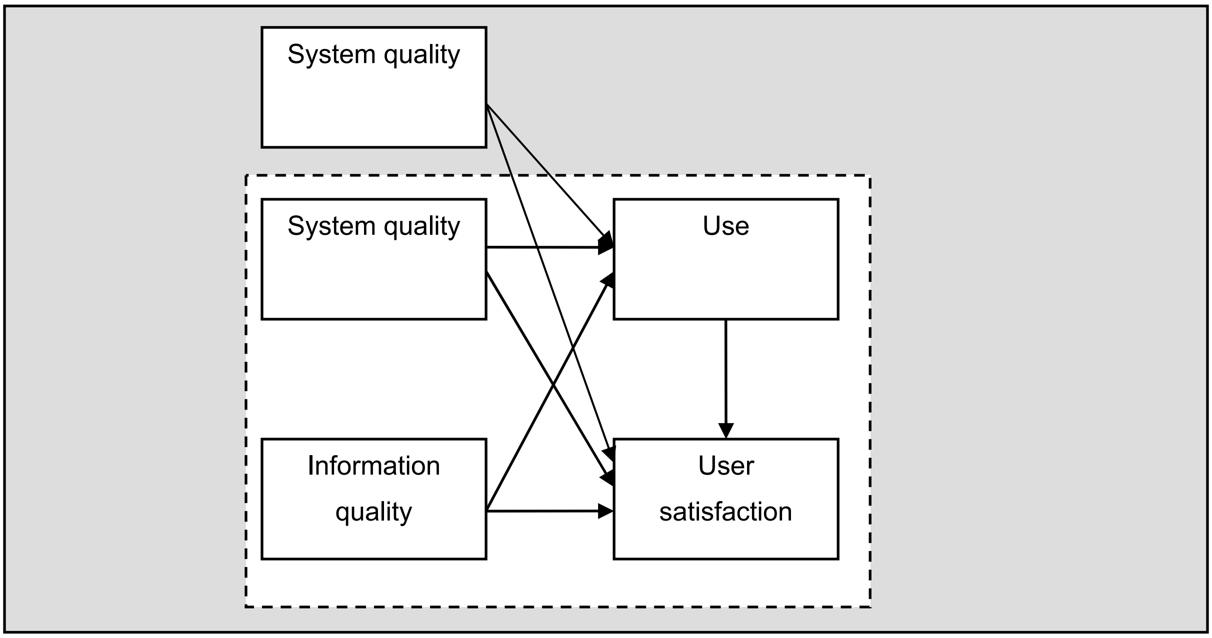

Figure 4.6: SEM of IS Success (Seddon, 1997).

Armstrong *et al.* (2005) furthered the study of Seddon and Kiew with the validation of a *Computer user satisfaction questionnaire* to measure IS success in small businesses. However, the "small businesses" only represented the sample group for data collection. The resulting questionnaire can be used to measure IS success at any size of business. After inspection of item content and statistical data, Armstrong *et al.* (2005) suggested item redundancy in Seddon and Kiew's instrument. In addition, Armstrong *et al.* (2005) attempted to make Seddon and Kiew's instrument more generic. After these modifications, the Computer user satisfaction (CUS) instrument consisted of 13 items, which measure information quality, system usefulness, system use, and overall satisfaction with the system.

As already indicated above, factors such as these measured by the CUS instrument is appropriate in the case of OSIS. This instrument incorporates the EUCS of Doll and Torkzadeh (1988), and the TAM's instrument of Davis (1989), which were discussed previously. Both instruments were found suitable for this study.

4.4 CONCLUSION

This chapter reviewed some of the fundamental theoretical instruments and models associated with the summative evaluation of successful information systems. This has been done by reviewing the nature of each instrument/model and a preliminary indication on the appropriateness of each instrument/model to the case of OSIS. A good understanding of these theoretical instruments is required to put into perspective the requirements of the users of the information system under evaluation.

The next chapter will present the synthesised data obtained from Chapter 3 and 4.

CHAPTER 5

SYNTHESIS OF DATA

5.1 INTRODUCTION

The previous two chapters described the data that was collected for this study. The research conducted for this study involved obtaining two sets of information. The first set of data included applicable information regarding the development, implementation and use of OSIS, which was presented in Chapter 3. The second set of data included information from literature on evaluating the success of an IS discussed in Chapter 4. In this chapter, the two sets of data will be synthesised by applying it to each instrument discussed in Chapter 4 in order to determine the appropriateness of each instrument in the case of OSIS.

The discussions in this chapter can be divided into three sections. The first section of the chapter describes the proposals that were received from business advisors working daily with OSIS regarding the nature of the OSIS-value instrument. This comprises what the “OSIS-value Instrument” should measure and how the value contribution of OSIS towards the organisation, the SAAF, can be recognised. The second section of the chapter will consider the measuring instruments and models in Chapter 4 and investigate their appropriateness in the case of OSIS. This discussion will be supplemented with proposals from the business advisors regarding the nature of the OSIS-value instrument. The last section of the chapter describes the OSIS-value instrument.

5.2 PROPOSALS FOR WHAT THE OSIS-VALUE INSTRUMENT SHOULD MEASURE

As pointed out in Chapter 4, it is difficult to measure the value an IS has for an organisation (Wateridge, 1998). One of the major problems in developing an appropriate instrument for an IT system is that the IT environment is dynamic, with constantly changing goal posts (De Beer, 2005). This implies that the OSIS-value instrument should be a reactive instrument; that is it will be used after the implementation of a system, in this case OSIS (De Beer, 2005). In Chapter 3, information regarding the value-contributing factors of OSIS, as perceived by the business advisors, was given. The following essential deductions were apparent:

Firstly, the main business objective of OSIS is to facilitate flying safety. Flying safety is influenced by a number of factors, such as the configuration management of the aircraft, aircraft serviceability and personnel competencies. These factors are dependent on the information supplied by the system (OSIS), and the integrity and the quality of the information should therefore be high. In order to produce this type of information, the system should be of a high quality. The OSIS-value instrument should therefore be able to measure system and information integrity and quality effectively.

Secondly, a supporting role of OSIS is to provide optimised logistical support and logistical resource analyses, which entail the accurate planning for logistical support for missions, maintenance, deployments and modification programmes. This is accomplished by using the data captured by OSIS to plan for these support events. This data can also be used for decision-making on the management level (see Figure 5.1 below). It is therefore imperative that the data captured by OSIS is accurate, timely, relevant and organised in such a way that queries can be done easily. The OSIS-value instrument should also measure these data characteristics.

Thirdly, because the development of OSIS was based on the basic logistical elements, the system forces users to adhere to these elements. This implies that users should have sufficient training to use the system and there should be support for the users of the system. What is therefore of importance to the OSIS-value instrument, is that it should measure whether the users are trained and able to use the system and to understand the environment in which they operate. Human nature allows one to do what is intended, not necessarily what is expected.

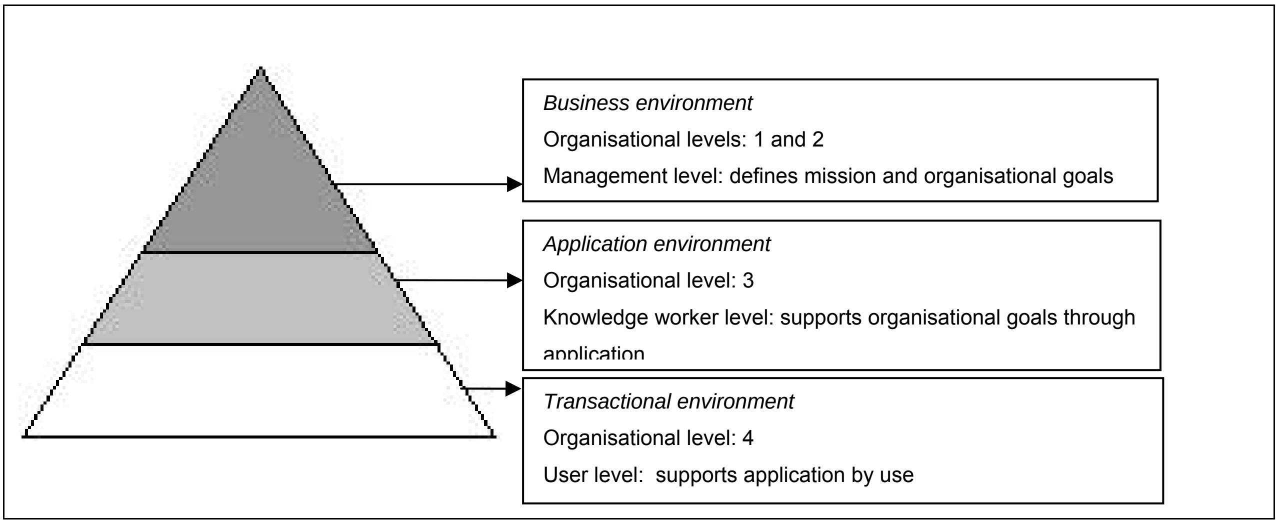

Figure 5.1: Organisational hierarchy of the SAAF (Greyling, 2005)

Lastly, with the introduction of the "computer network" concept, a number of doors have opened for managers. One important aspect resulting from the dispersed SAAF operating environment is the immediate visibility attribute that OSIS provides. This attribute might be perceived as most important at management level as they now have real-time data on operations at any OSIS implemented unit.

5.3 DISCUSSION OF THE VARIOUS IS MEASURING INSTRUMENTS AND THEIR APPROPRIATENESS TO OSIS

In Chapter 4, eight measuring instruments and three measuring models were discussed. Preliminary indications were given on the appropriateness of each instrument and model in the case of OSIS. In this section, those preliminary indications and the proposals received from Section 5.2 will be synthesised. It is evident, from the discussion in Section 5.2, that the OSIS-value instrument should have strong information and system quality characteristics. It should include a component on user competency (that includes training and ability to use the system) and on user-friendliness.

5.3.1 User information satisfaction (UIS) and OSIS

The UIS instrument focuses on information quality. It is evident from Section 5.2 that the OSIS-value instrument should have strong information quality characteristics. From Chapter 4 it can be observed that the UIS instrument can be used as a measure for information quality. This instrument measures factors such as the integrity, reliability, accuracy and precision of the information generated by a system. This instrument can be used to measure the information quality at any organisational level (see Figure 5.1).

However, the UIS instrument only focuses on the information quality of the system. The aspects mentioned in Section 5.2, such as system quality, user competency and user-friendliness, are not measured by this instrument. Even though the UIS instrument in its individual capacity has been used to evaluate the success of an information system, it is not comprehensive enough as an OSIS-value instrument. It is therefore concluded that this instrument is appropriate to measure the information quality aspects of OSIS; it is however not comprehensive enough to measure all aspects concerning the contribution of OSIS to the SAAF.

5.3.2 End-user computing satisfaction (EUCS) and OSIS

The motion for the use of user satisfaction as a surrogate for system success was supported by other researchers such as Doll and Torkzadeh (1989) who developed the **end-user computing satisfaction** (EUCS) instrument. Similar to the UIS instrument, the EUCS instrument is based on the user satisfaction surrogate of system success. This instrument comprises five component measures: content, accuracy, format ease of use, and timeliness.

The EUCS concentrates on the user's satisfaction with the system, for example that the user is satisfied to work with the system and the output of the system? Proposals from Section 5.2 regarding the OSIS-value instrument included the correct format, user-friendliness and timeliness. These proposals are included and measured by the EUCS instrument. Similar to the UIS instrument, this instrument can be used to measure user satisfaction at any organisational level (see Figure 5.1). However, the transactional user (lowest organisational level) who works on a daily basis with OSIS (capture data, process data and retrieve information) will be able to give the most accurate picture. The higher organisational levels will only be affected if the information requested is not in the correct format or timely.

Nevertheless, the same argument for the UIS instrument is also valid for the EUCS instrument. The EUCS instrument only measures user satisfaction. Similar to the UIS instrument, the EUCS instrument, on its own, also has been used as surrogate for system success by a number of studies (see Somers *et al.*, 2003; Henry and Stone, 1994). Nevertheless, for the purposes of this study it is felt that the EUCS instrument is not comprehensive enough to encompass all aspects of system success to serve as an OSIS-value instrument.

5.3.3 Servqual and OSIS

Research has proved that service delivered to IS users is an important role of the information systems department. With the emergence of end-user computing the quality of service rendered by the IS departments became more prominent (Grover *et al.,* 2004). As was seen in Chapter 4, the Servqual+ instrument (Kettinger and Lee, 1997) focuses on four characteristics: reliability, responsiveness, assurance, and empathy with up to three dimensions: minimum service level, desired service level and the perception of the delivered service level.

In Section 5.2, no proposal was made to include a measure for service quality in the OSIS-value instrument. This might result from the fact that the interviewees who are rendering the service felt that their service is up to standard. In the DoD, an outside organisation, the State Information Technology Agency (SITA), renders IS services to the organisation. As was mentioned in Chapter 3, the source code for OSIS resides with SITA. SITA therefore renders a service to the SAAF in this case by employing consultants to act as business advisors to the SAAF regarding the implementation, use and further development of OSIS. The moment a service is rendered to an organisation, service level agreements (SLAs) have to be drafted in order to determine the scope of the required services.

Similar to the user satisfaction instruments, this instrument can be used to measure the service quality at any organisational level (see Figure 5.1). They will know if the service they receive allows them to do their work, and thereby using OSIS, without any problems. Furthermore, in the event that users do experience problems, or have new requests, it is important to measure how the IS department respond to the users' needs.

For the above reasons, it is felt that there is a need to include a service quality measure in the OSIS-value instrument, and the researcher proposes the Servqual instrument with one dimension: perception of service performance.

5.3.4 Management information system (MIS)/decision support system (DSS) and OSIS

The MIS/DSS instrument concentrates on measuring the ability of an IS or DSS to support decision-making and contribute to the user's overall satisfaction. Ultimately, the instrument can be used to measure organisational effectiveness, since a definite link has been identified between organisational goal achievement and the quality of individual decision-making (Sanders, 1984).

The aim of this study is to develop an instrument which can be used to evaluate the value added by the IS to the organisation. As indicated in Chapter 3, one of the main functions of OSIS is to supply management level with information for decision-making. The MIS/DSS success measure provides a means for measuring the value added to the organisation as a result of the provision of the information from the system, which has an impact on decision-making. It will thus be appropriate to measure to which extent OSIS succeeds in supporting the SAAF by providing information for decision-making. However, as in the case of the UIS, EUCS, Servqual, TTF model and TAM, this instrument only focuses on one aspect of an organisation. Consequently, the MIS/DSS success measure cannot be used individually as a measure for the OSIS-value instrument.

5.3.5 Information orientation (IO) and OSIS

The IO (Marchand *et al.,* 2001a) metric is comprehensive and well balanced. It measures and works on the principle of how well an organisation manages its information, which can then be used to improve certain business performance aspects (based on the balanced scorecard concept by Kaplan and Norton (1999)), by identifying the problematic aspects using the IO dashboard.

This metric does not explicitly measure the information quality and system quality concepts that were proposed in Section 5.2 for the OSIS-value instrument. For example, the information integrity characteristic of the information behaviours and values capability of this metric, concentrates on the integrity of the worker/user of the system not to pass on information knowingly. It does not measure the capability of the system to produce quality information. The IT practices and the information management practices capabilities of this metric also do not explicitly measure the other proposals, such as the user-friendliness and the ability to measure the IS services rendered to the users of the system.

Furthermore, the IO metric was specifically developed to be used with the assistance of the CEOs of an organisation. That implies the assistance of the managers at the top level (see Figure 5.1) of an organisation. In the SAAF, this might present a challenge. Managers at that level might not always know which problems are experienced by the end-users of OSIS on the transactional level (see Figure 5.1).

However, this metric can be used at a later stage as a key performance indicator over time to assess the effectiveness of management actions to improve information behaviours and values, information management practices and IT practices. Moreover, the business performance side of this metric can be adapted to be applicable to the non-profitable nature of the SAAF to measure effective performance.

5.3.6 Tobin’s q and OSIS

This instrument compares, by means of a ratio, the market value of the firm to the replacement cost of its total assets. Preliminary indications in Chapter 4 suggested that this instrument is not appropriate in the case of OSIS. The following conclusive remarks can be made regarding the appropriateness of this instrument to the case of OSIS:

Firstly, Tobin's q is based on monetary concepts, which are difficult to quantifyin the case of a non-profitable organisation such as the SAAF. Secondly, to calculate the amount of development of OSIS will be a complex exercise that will have to date back to the 1980s, when the first concept of a logistical information system was introduced, which ultimately resulted in OSIS. Finally, as had already been indicated in Chapter 4, Tobin's q ignores intangible assets in the calculation of the return of investment to the company.

The researcher proposes that this instrument could not be used successfully to evaluate the success of an information system because an information system includes necessary intangible, non-quantifiable value creation aspects such as opportunities for people with disabilities and quality-of-life improvements.

5.3.7 Balanced IS scorecard and OSIS

Kaplan and Norton (1999) have received a great deal of positive feedback after the development of the balanced scorecard concept. As was seen in Section 4.2.3, Marchand *et al.* (2001a) used the balanced scorecard concept as foundation for the business performance side of their information orientation dashboard. Prior to that, Martinsons *et al.* (1999) have developed the balanced IS scorecard, which was based on the original scorecard developed by Kaplan and Norton.

It is proposed that this instrument is appropriate in the case of OSIS. Like the original balanced scorecard, the balanced IS scorecard does not only focus on the monetary issues of an organisation, but also takes into account the intangible issues, such as the end-user views. Because the SAAF is a non-profitable organisation, it requires a different measure of what is considered a successful investment. This instrument also includes the service quality aspect (discussed in section 5.3.3), which was deemed important by the researcher. However, the balanced IS scorecard does not allow for evaluating the specific aspects of information and system quality, which were considered important by the input received from the interviewees.

5.3.8 Asset specificity and asset scope (ASAS) and OSIS

The assets specificity and asset scope (ASAS) approach attempts to isolate the information system from its operating environment in order to obtain the value added by the system to the organisation, without the influence of the factors introduced by the surrounding environment.

The ASAS instrument concentrates on every value-creating aspect of the IS, whether it is operating on the first or on the third organisational level, thereby fulfilling the requirement regarding organisational level. The dependency network diagram (DND) methodology allows an organisation to repeat this evaluation process with any other system, in any other department. The sets of value-producing activities resulting from the evaluation can be compared against the organisation's goals for appropriateness, or the organisation's strategies can be realigned to capitalise on new competencies offered by the IT assets.

This instrument provides a new slant on determining the value added to an organisation through the implementation of IT. Traditional measuring instruments made use of a questionnaire to determine whether the user is satisfied with the report delivered as output from the system (as in the UIS instrument). The DND methodology, however, requires a resource-deficient asset, thereby placing a need (a particular report) on the supplying resource. One of the abilities of the supplying resource will then be to provide the requested report.

However, this approach does not evaluate explicitly, as is the case with the aforementioned instruments, for example, whether the user is satisfied with the content, format and timeliness of the requested report. Thus, as had already been indicated in Chapter 4, this approach is complex to apply and requires information regarding each activity of the OSIS and the dependencies placed on it. This will be difficult to accomplish with the shortage of technical personnel, as was described in Chapter 3. However, this instrument will be very appropriate in an organisation where one is convinced that the system fits the task requirements and that the human factor will not decrease the possible value contribution of the system.

5.3.9 Key performance indicator (KPI) model and OSIS

KPIs are measures of the performance or progress towards the objectives of an organisation. However, KPIs can be modelled to be a practical approach that can be used to determine the value added to an organisation by the introduction of an IS, in this case OSIS. The KPI model does not have a measuring instrument, similar to the DeLone and McLean IS success model (DeLone and McLean, 2002), to measure the KPIs of the organisation. However, the KPIs of an organisation is specified based on the goals and strategy of that organisation during the mission and vision formulation.

In the case of OSIS, the business advisors (mentioned in Chapter 3) who work with OSIS daily, proposed a KPI model that can be used to obtain the research goals. It is an organisation-wide model, implying it can be used across organisational levels. In addition, the model can be adapted for the specific situation.

However, a KPI model should list the key performance indicators for the system. These indicators should be quantifiable, which can be problematic in some cases. By listing all of these indicators, the list might become quite extensive.

5.3.10 Technology acceptance model (TAM) and OSIS

Measuring instruments of system quality focus on performance characteristics of the system under study, such as reliability, response time, ease of use, usefulness, flexibility, and accessibility. Following the discussion in Section 5.2, it was proposed that a measure of system quality be included in the OSIS-value instrument as the quality of the OSIS is deemed important by the interviewees. The researcher and other researchers such as Seddon *et al.* (1999) support this motion for system quality.

Perceived in that light, the TAM could be deemed appropriate in the case of OSIS, because the measuring instrument of the TAM – a 12-item instrument – can be used to measure system quality as the model measures the perceived usefulness and perceived ease of use of a system.

However, the TAM is commonly used in conjunction with the TTF model (see 5.3.11 below). Because some aspects of this model are appropriate for the OSIS-value instrument, it should therefore be included to measure the system quality aspect of OSIS.

5.3.11 Task technology fit model and OSIS

The task technology fit model (TTF) (Goodhue *et al.,* 2000) measures the degree to which the task fits the technology, task characteristics and the individual performance impact. This model was originally proposed as a third theoretical basis for system success measures. The TTF model's measuring instrument, a 41-item instrument, attempts to indicate that the performance impact of an IS is dependent on the fit between technology characteristics, task requirements, and individual abilities. This measuring instrument can also be used to measure the information system's impact on the individual (see Appendix B, section B).

This model can thus be used to evaluate to which degree OSIS fits into its environment. Even though OSIS was specifically developed for the SAAF, the client's needs might have changed. This model can also be a measure for system quality aspects, such as system reliability, which was motivated as important in Section 5.2. In addition, this model includes aspects such as user training, output timeliness, reliability of information, ease of use, compatibility of the system and impact of the system on an individual's performance.

However, the instrument only measures a certain perspective on system success even though it includes more aspects than some of the other measures mentioned above. It is therefore proposed that the aspects measured by this instrument be included in the OSIS-value instrument.

5.3.12 Delone and Mclean IS success model and OSIS

The DeLone and McLean's IS success model (1992) depicts the relationships of six IS success dimensions, namely information quality, system quality, service quality, use/intention to use, user satisfaction and net benefits. These IS success dimensions are the foundation for the proposed framework for assessing the effectiveness of the IS function.

Unlike the TAM and the TTF model, the DeLone and McLean IS success model, does not have its own measuring instrument. In fact, DeLone and McLean (1992) emphasised the need for additional research for the selection of measures for each IS success dimension.

The reformulated IS success model, as foundation for a success-measuring instrument, is appropriate in the case of OSIS. In Section 5.2, it was clear from their input that the interviewees deemed information, service quality and user friendliness important. Following on the findings, the researcher felt compelled to include service quality as another necessary attribute of the OSIS-value instrument. The net benefits dimension will necessitate a measuring instrument that will measure the benefits to a specific stakeholder. In the case of OSIS, the benefits (positive or negative) will be directed to the organisation. Thus, a measuring instrument that will measure the effect of an IS on the organisation is required.

Furthermore, this model allows for the measuring instruments to be applied where appropriate across the organisational levels. If this model was therefore used as framework for the OSIS-value instrument, the nature of the instrument would conform to that what was proposed in Section 5.2.

5.3.13 Structural equation model (SEM) of IS success and OSIS

The SEM of IS success, which yielded the computer user satisfaction (CUS) instrument, measures IS success by evaluating four characteristics, that is information quality, system usefulness, system usage, and overall satisfaction. This instrument is based on a part of the DeLone and McLean IS success model framework, which had already been indicated as being appropriate to OSIS. In addition, this instrument incorporates the EUCS instrument (Doll and Torkzadeh, 1988) and the TAM's instrument (Davis, 1989). Both of these instruments have been discussed previously and the researcher has already commented on the applicability of each instrument in the case of OSIS. It was stated that each instrument will not be comprehensive enough on its own, but the CUS has now combined, the two measuring instruments into one instrument.

It has furthermore already been indicated that the first characteristic of CUS, for example information quality, is imperative to the OSIS-value instrument. In addition, the second and third characteristics of CUS, namely system usefulness and system usage (both of which are indicators of system quality) have also been identified as a necessary characteristic, which should be addressed by the OSIS-value instrument. The last characteristic of CUS, overall satisfaction, will allow users the opportunity to give their overall impression of OSIS, which can be an indication to management of how OSIS is received in the organisation.

However, CUS is based on the original DeLone and McLean IS success model. Since Seddon and Kiew's study in the middle 1990s (cited in Seddon, 1997), the reformulated DeLone and McLean IS success model has been developed as an answer to the criticism received from peers. Two success dimensions were dramatically changed, firstly, the introduction of service quality and secondly, the collapse of individual performance and organisational performance into net benefits. The CUS does not address these changes, and it only focuses on part of the original model. It has been argued previously that service quality is an important characteristic that should be addressed by the OSIS value instrument. In addition, the OSIS-value instrument should have characteristics that measure the influence of OSIS on the organisation.

Nevertheless, CUS is appropriate in the case of OSIS as it measures for important characteristics that should be addressed by the OSIS-value instrument. The CUS instrument succeeds to combine the EUCS (Doll and Torkzadeh, 1988) and the TAM (Davis, 1989) and other not discussed instruments into one validated instrument.

However, the instrument will not be sufficient to be used on its own, and should be supplemented with instruments that measure the other characteristics that should have been addressed by the OSIS-value instrument.

5.4 THE OSIS-VALUE INSTRUMENT

From the preceding research, it is evident that the success of an information system is a multi-dimensional concept (to incorporate the perspectives of the different stakeholders). It will be incorrect to use only a single perspective-measuring instrument (for example user satisfaction) as a surrogate for system success. The nature of OSIS also necessitates conforming to this statement. After comparing which characteristics are necessary for the OSIS-value instrument and which can be obtained from examining the subjectively chosen measuring instruments and models, the researcher concludes that the OSIS-value measuring instrument should be based on the foundation of the reformulated DeLone and McLean IS success model (see Figure 5.2).

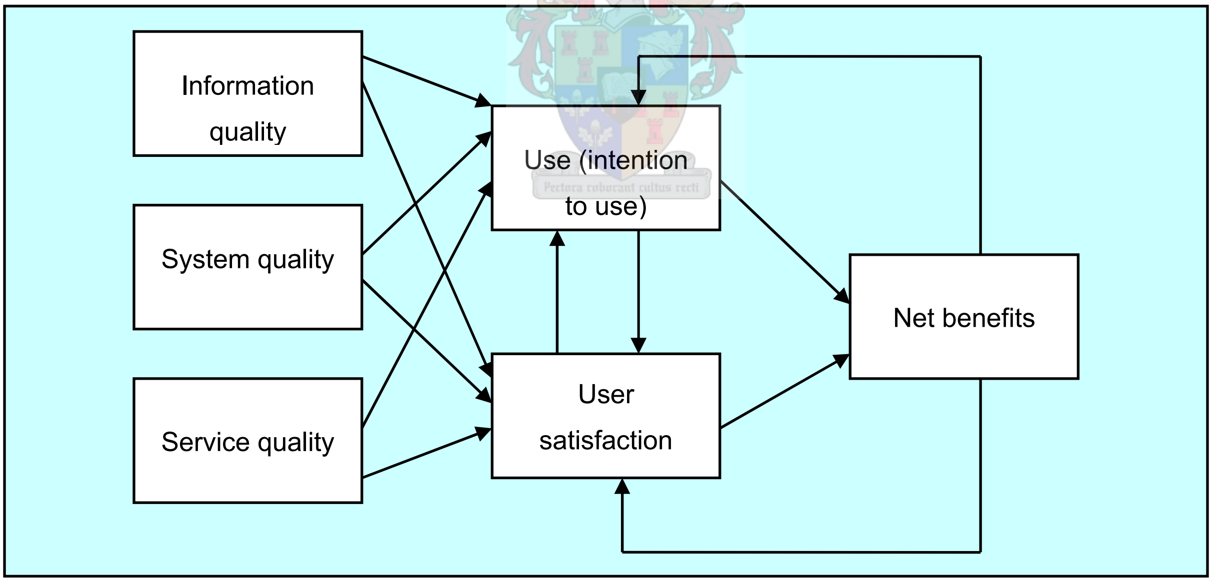

Figure 5.2: The reformulated IS success model (DeLone and McLean, 2002)

It is evident from the discussions above that all six dimensions of the reformulated DeLone and McLean IS success model (see Figure 5.2) are appropriate and necessary in the case of the OSIS-value instrument. By choosing this model as framework for the OSIS-value instrument, it is implied that a measuring instrument has to be identified for each of the six success dimensions. Table 5.1 depicts the instruments that have been subjectively identified by the researcher for each success dimension. It is important to mention that the value added by OSIS to the SAAF will be measured by evaluating how OSIS characteristics such as information and system quality scored on seven-point Likert scale (see individual characteristics in Table 5.2). The OSIS-value instrument will graphically represent the value determining characteristics (see Appendix B).

Table 5.1: Measuring instruments identified for each IS success dimension

IS success dimension	Measuring instruments proposed
Information quality	Computer user satisfaction (Armstrong *et al.,* 2005)
System quality	Computer user satisfaction (Armstrong *et al.,* 2005) Task technology fit model (Goodhue *et al.,* 2000)
Service quality	Servqual (Kettinger and Lee, 1997)
Use/Intention to use	Task technology fit model (Goodhue *et al.,* 2000)
User satisfaction	Computer user satisfaction (Armstrong *et al.,* 2005)
Net benefits	MIS/DSS success measure (Sanders, 1984)

The following conclusive remarks can be made regarding an appropriate measuring instrument for each of the six information system success dimensions:

Firstly, information quality measuring instruments focus on the output produced by the IS and the value, usefulness or relative importance attributed to it by the user. Most of the measures developed to measure information quality are therefore perceptual by nature. The user information satisfaction instrument by Bailey and Pearson (1983) has received most attention in the area of information quality. However, the UIS was criticised because of its limited applicability to information systems as a whole and its poor theoretical base. Subsequent user satisfaction instruments, such as the EUCS instrument (Doll and Torkzadeh, 1988) and the CUS (Armstrong *et al.,* 2005) that incorporates amongst others the EUCS (based on the UIS) have been developed. The researcher proposes that the information quality aspect of OSIS will be sufficiently addressed by the CUS's information quality characteristic that uses a seven-point Likert scale.

Secondly, system quality measuring instruments focus on performance characteristics of the system under study, such as reliability, response time, ease of use, usefulness, flexibility, and accessibility. Davis' (1989) technology acceptance model (TAM) measures the *perceived usefulness* and *perceived ease of use of a system*. However, these characteristics are also present in the CUS that incorporates the TAM. Thus, the researcher proposes that the CUS's system usefulness and system usage characteristics will be appropriate to address the system quality aspect of OSIS. However, the CUS will be supplemented with items from the task technology fit model (Goodhue and Thomson, 1995) that will be discussed later. The TTF has the following characteristics to measure system quality: system reliability, ease of use, and production timeliness.

Thirdly, research has proved that service quality, over and above that which the information system has delivered, is an important part of the role of the information systems department. Researchers who have argued to have the service quality dimension added to the success model have applied and tested the Servqual measuring instrument (Kettinger and Lee, 1997). However, the researcher feels that the Servqual+ instrument (Kettinger and Lee, 1997) that focuses on four service quality characteristics, such as reliability, responsiveness, assurance, and empathy within one dimension, namely perception of the delivered service level, will be appropriate and able to measure the quality of service the OSIS users receive. The Servqual instrument uses a nine-point Likert scale, but, in order to make the consolidation of measures easier, the researcher proposes that no information will be lost, due to the closeness of the intervals, when it is converted to a seven-point Likert scale.

Fourthly, the actual use of a computer system can be affected by the degree to which system characteristics match user task needs (Goodhue *et al.,* 2000). In the researcher's opinion the task technology fit (TTF) model will be appropriate to measure the use of OSIS successfully and to establish whether it is appropriate for the task at hand. The TTF suggests that better outcomes (i.e. performance) will result when there is a match between the task and the technology used. The TTF's measuring instrument includes items to assess the quality, currency, relevance (also covered in the UIS instrument) and locatibility of data (ease of determining which data is available and where); ease of use of the system (also included in the CUS), response time and presentation. This measuring instrument can also be used to measure the information system's impact on the individual. The TTF makes use of a seven-point Likert scale.

Fifthly, the dependence on user satisfaction in measuring information system success is common and several instruments have been developed and tested. The user satisfaction dimension in the success model is an important theoretical issue that has received considerable attention (Grover *et al.,* 2004). The end-user computing satisfaction (EUCS) instrument (Doll and Torkzadeah, 1988) is a 12-item application-specific instrument for providing an overall assessment of end-user computing satisfaction. This instrument comprises of five component measures: content, accuracy, format, ease of use, and timeliness. Because the CUS incorporates the EUCS amongst other satisfaction instruments, it is therefore possible that the CUS might be appropriate to measure the users' satisfaction with OSIS.

Finally, the net benefits dimension indicates that an outcome of the evaluation of a system may be either positive or negative for the predefined stakeholder. In the case of OSIS, the organisation (the SAAF) is the major stakeholder. The MIS/DSS success measure (Sanders, 1984) concentrates on the perceived usefulness of the information system to the organisation and the decision-making satisfaction derived from using the system. The researcher is therefore of the opinion that this measure will be used to evaluate organisational benefits derived from implementing OSIS. The MIS/DSS success instrument makes use of a five-point Likert scale. However, for consolidation and uniformity purposes, the researcher proposes that if the five-point scale is converted to a seven point Likert scale, more information might be inferred from the measurement.

Table 5.2 (above) gives an indication of which aspects the OSIS-value instrument will address. This arrangement is by no means ideal, because some of the measuring instruments do have common characteristics (for example the US and TTF instruments both measure ease of use of a system).

However, having identified the measuring instruments for each success dimension, further research should now be done to eliminate redundant items in order to streamline the four different measures into one comprehensive measuring instrument for the reformulated DeLone and McLean IS success model. Nevertheless, the OSIS-value instrument based on the reformulated DeLone and McLean IS success model, regardless of whether it is one streamlined instrument or four individual instruments, will be able to determine to which extent OSIS adds value to the SAAF.

Table 5.2: Summary of measuring instrument criteria

Instrument	US	TTF	Servqual	MIS/DSS
Information quality	×	×		
System usefulness	×			×
System ease of use	×	×		
Users' overall satisfaction with system	×			
Timeliness of information		×		
Locatability of information		×		
Authorisation for system use		×		
Compatibility of system		×		
Relationship with users by IS service staff		×		
Task characteristics		×		
Task equivocally		×		
Task interdependence		×		
Individual performance impact using the system		×		
Reliability of IS service quality rendered			×	
Responsiveness of IS service quality staff			×	
Assurance of IS service quality staff			×	
Empathy of IS service quality staff			×	
Decision making satisfaction				×

The OSIS-adapted instruments will be presented in Appendix B as the OSIS-value instrument questionnaire. The questionnaire is divided into four sections (Section A – D). After each section, the method of interpretation is presented. All of the sections make use of descriptive statistics to interpret the data. The final results will be presented graphically.

5.5 CONCLUSION

This chapter has provided a systematic discussion on the development of the OSIS-value instrument. This has been achieved by investigating two aspects: the nature of the OISIS-value instrument and the appropriateness of each summative information system success instrument/model in the case of OSIS. The latter part was accomplished by weighing the instrument's measuring characteristics against what was perceived as important characteristics for the OSIS-value instrument.

Indications were given that a number of the instruments discussed in this chapter are to some extent appropriate in the case of OSIS. However, it should be noted that by reason of the nature of the OSIS operating environment none of the measuring instruments discussed so far, with the exception of the reformulated DeLone and McLean IS success model, is individually appropriate, as the OSIS-value instrument. The reformulated DeLone and McLean IS success model incorporates the necessary aspects of perceived system success but does not have a measuring instrument of its own. The researcher subjectively identified a measuring instrument for each of the six IS success dimensions of the reformulated model. Furthermore, indications were given as to the characteristics of the OSIS-value instrument.

The next chapter will present the final conclusions and recommendations of the study.

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

In Chapter 1, it was stated that the purpose of this study was to develop an appropriate instrument to evaluate whether OSIS adds value to the SAAF. Hence, this study explored measures that can be used to evaluate the success of information systems and background knowledge on OSIS that can contribute to the development of an appropriate instrument to evaluate the value of OSIS to the SAAF.

To achieve this, the study commenced with an outline of the research process that was followed in order to obtain the research results in Chapter 2. Chapter 3 focused on the background of OSIS and contributions from the experts in the field pertaining to the value OSIS has added to the SAAF. Chapter 4 provided a fundamental theoretical synopsis of the subjectively determined information system success measuring instruments.

6.2 SUMMARY OF THE STUDY

The investment in IT has increased rapidly with a total investment worldwide of over two trillion dollars annually (Turban *et al.*, 2005). Companies often invest in IT out of strategic necessity. However, the investment in IT alone is seldom sufficient to guarantee continued business performance (Marchand *et al.,* 2001a). The SAAF, being a non-profitable organisation, stands not shy of expecting the same return on investment. It has invested a large amount of resources over the past years (starting in the 1980s) in the development of a logistical information system (OSIS). Tangible results were not always visible, and that prompted for a means to evaluate OSIS formally in order to show whether the investment is indeed viable.

This present study provided the background for the development and evolution of SLIS to OSIS. This background detail was supplemented with interview data and recent documentation to sketch an overall picture of OSIS's current position within the DoD environment.

Valuable information was obtained from the interviewees regarding the contribution of OSIS to the SAAF. The negative aspects associated with OSIS were also presented. The researcher used this information to identify proposals for the OSIS-value instrument characteristics.

A scrutiny of the IS literature suggested the existence of a proliferation of measuring instruments to determine the success/value of information systems. An initial set of twelve measuring instruments/models to evaluate the value of IS was identified during the literature survey. The approach followed was semi-structured and subjective.

Each of the thirteen instruments/models was examined and the appropriateness of each in the case of OSIS was discussed. Based on the appropriateness of each instrument, and the proposed nature of the instrument under development, the researcher argued which instrument would be the best to serve as, or framework for, the OSIS-value instrument.

After constructive arguing, the researcher has concluded that the reformulated DeLone and McLean IS success model was deemed the most appropriate to be used as framework for the OSIS-value instrument. Six measuring instruments were subjectively identified for each of the six success dimensions in the reformulated model. The questionnaire for the OSIS-value instrument was prepared and is presented in Appendix B.

6.3 RESEARCH CONCLUSIONS

The research conclusion section is a fundamental part of any documented research. This section illustrates to the reader the thoroughness of the process followed to reach the research result. Because of the importance of this section, the researcher felt it appropriate to divide the section into two parts. The first part discussed important conclusions regarding the challenges experienced during the research process. This is to aid fellow researchers to avoid pitfalls in the research process and to show what the researcher has learnt about the specific research environment. The second part of the section discussed important conclusions regarding the research result obtained. This was used to help the researcher communicate to the target audience – SAAF management, peer IS researchers and OSIS developers – the rationale and validity of the study.

6.3.1 The research process

One of the important lessons learnt from the research process was that regarding the scope of the research. The study commenced with the aspiration to determine the success of OSIS. However, after the colloquium the researcher was thoroughly convinced that such a study would be "ambitious" for the allocated time span and too large for the required level. Thus, the scope of this research excluded the actual evaluation process. It is important, for any researcher to balance the "time available" with "what needs to be done" and "how it will be done".

The "how the research will be conducted" also introduces spatial challenges. In the case of this research, the researcher was located in Saldanha and the interviewees in Pretoria. This presented challenges pertaining to interviews, whether telephonic or physical. This had a great impact on the time research plan of the researcher. In addition, the researcher had to commute between Saldanha and Pretoria for the events of physical interviews, which was costly and subjected to time constraints. It is important for any researcher, finding himself/herself in similar circumstances, to allow for such eventualities in the research timeline.

As the research progressed, it was evident that there are no set rules to follow when conducting research. The important thing is to document all the steps and to motivate the decisions made. The environment of the research, especially in qualitative research, dictates the research methodology. Furthermore, it is not necessary to choose one existing research method, but approaches can be combined or, as in the case of this research, a unique research model developed as the research progresses.

With any research, the researcher should know when to draw the line, especially in a research area, which is vast, as is the case with this research. The researcher has found that there are a number of different evaluation instruments and models available, which can be used to evaluate the success of an information system. This study only subjectively identified thirteen of them. In addition, due to the fact that this study spanned over the course of two years, instruments and models became updated, such as in the case of the TAM and the DeLone and McLean IS success model. The researcher has attempted to incorporate the most up-to-date research available, thereby including asset specificity and asset scope, and structural equation modelling of an IS, and thereby only mention the recent updates of the two above-mentioned models.

In conclusion, when doing research that is linked to the practice (OSIS is implemented by an existing organisation, the SAAF) one might experience that practise and theory differ as to what is important. There is still some debate about the value of research as a contributing factor to the industry.

6.3.2 The research result

The inability for organisations, in particular the SAAF, to account for investments in information technology are still a large problem. This problem is evident in the SAAF with the absence of and subsequent request for a formal evaluation of the value added to the SAAF by the investment in OSIS. The research was only concerned with the development of an appropriate measuring instrument.

This study indicated that there is a diverse disposition towards the success of OSIS by the different stakeholders. Senior managers rightly questioned the viability of OSIS before further investment of more resources. OSIS users believed in their ignorance that OSIS “does not work” due IT problems (e.g. restricted bandwidth and server downtime) that are a non-OSIS related problem. However, the positive inputs obtained from the interviewees indicated their belief in the abilities of OSIS to be an asset to the SAAF.

As a result of this research, the business advisors were compelled to have a closer look at OSIS. This allowed them to document, for the first time, the value-contributing factors associated with OSIS. In addition, the negative aspects associated with OSIS, were voiced and documented. The importance of the human factor firstly, and secondly resource restrictions visible in absence in the availability of sufficient bandwidth were emphasised. The deficiencies in the organisation, for example managers who do not understand the business rules of its directorate, were also highlighted. These factors, positive and negative, should be addressed by the OSIS-value instrument in order to indicate where improvements, not only in the system, but also in die organisation can be made.

In view of the hypothesis, it is clear from the previous discussion that an instrument, the OSIS-value instrument, has been developed and can be used to measure the extent to which OSIS adds value to the SAAF. The SAAF, being a non-profitable organisation was not concerned with the measurement of the monetary-based success of OSIS. This steered the research in the direction of surrogate measures for success. The OSIS-value instrument reflects that by surrogate measures based on the perception of the OSIS stakeholders. However, the OSIS-value instrument has not yet been tested. In addition, the OSIS-value instrument, as previously indicated, does have some redundant characteristics, which can be streamlined in future studies.

From the research it can be concluded that an investment in and implementation of an IS alone are not enough to ensure the success of that IS. One cannot exclude the human factor in the IS operating environment. In addition, the preceding research confirms that the success of an IS is a multi-dimensional concept (to incorporate the perspectives of the different stakeholders). Research has indicated that OSIS has all the qualities of a successful system. This is evident in the fact that the commercial version of OSIS is very successful in foreign countries.

Furthermore, as described in Chapter 3, the implementation of OSIS has introduced a number of benefits to the SAAF. Yet, the diverse disposition as regards the success of OSIS indicates that intangible components, such as human and IT infrastructure components, influence the perception of success. Through this study, OSIS has been assessed, including the identification of a number of positive and negative factors associated with the implementation of OSIS. These factors, especially the negative aspects, should now be addressed and acted upon by management in order to concentrate organisational resources to produce more of the positive factors of OSIS.

The interaction of the system (OSIS), humans and IT presents a number of challenges to the SAAF. It is often difficult to isolate where a weakness resides. However, through the development of a multiple perspective OSIS-value instrument, the researcher attempted to provide management with a tool that can be used to indicate a problem area effortlessly. The OSIS-value instrument will divide the problem area into six domains, namely those of information quality, system quality, service quality, use of system, user satisfaction, and organisational impact. With the exception of the information quality domain that gives a single score for the users' perception of information satisfaction, the other domains' interpretation allows for categorical analysis. These categorical analyses will aid the manager to pinpoint the category where lower than desired scores were achieved.

6.4 RESEARCH RECOMMENDATIONS

The researcher has already identified a positive aspect of this research, namely that negative aspects regarding the implementation of OSIS were highlighted. One of these aspects was the training of users. The negative factors associated with OSIS could be minimised if users are trained correctly. This includes orientation of users as regards that which OSIS entails and those secondary factors influencing the performance of OSIS and training them to use the system to its fullest potential. Thus, the users will be empowered to identify and make suggestions to address the real problems, which will in turn aid management.

Versions of OSIS can be traced back to the 1980s. Because this is a system that has evolved over time, management should allocate time to do the formal evaluation now that an appropriate instrument has been developed. This would take in the region of three months for an evaluator to travel between the dispersed units to do stratified random sampling between different stakeholders.

Preliminary indications were also obtained by the researcher that the further development and implementation of OSIS are feasible and recommended. In addition, a bigger budget for the infrastructural requirements for the optimum operating environment of OSIS, such as increased bandwidth by having a dedicated network line and at least entry-level workstations and servers, will also contribute to the increased value of OSIS to the organisation. This would decrease some of the secondary problems (that is problems that are not directly related to OSIS) experienced by OSIS users.

The evaluation process itself would not hold any major monetary implications to the organisation. The evaluator should preferably be an independent person, such as the researcher. The majority of the expenses will be for travelling and accommodation of the evaluator, and also the preparation of the questionnaires.

The SAAF and consequently the DoD have spent a large amount of resources (such as money, work force and time) on the development and implementation of OSIS. However, only the SAN has made use of the resulting system. There are a number of indicators that suggest that OSIS is a successful system. The researcher therefore recommends and supports the discussions that are being held concerning the standardisation of the DoD's logistical information systems based on OSIS.

This research attempted to provide the SAAF with an instrument to measure the extent to which OSIS adds value to the organisation. However, this instrument can be adapted and applied to measure other information systems within the DoD, or any other non-profitable organisation.

6.5 FURTHER RESEARCH

This study initially indicated that options for further research would be available as it was outside the scope of this study to do the actual evaluation of OSIS. However, after the development of the OSIS-value instrument, certain research opportunities have been identified.

Firstly, before the validation and verification of the OSIS-value instrument, the researcher might wish to conduct another set of interviews with the business advisors to confirm the result of their brainstorming, and also conduct interviews with other stakeholders, such as the users of OSIS. This will provide the researcher with a "feedback loop" to confirm that all the data collected through the interviews are correctly interpreted. The researcher should also obtain views from the other OSIS stakeholders as "combining the view of the different stakeholders" is a major part in the reformulated DeLone and McLean IS success model, on which this study is based.

Secondly, as some of the instruments and models, such as the TAM and reformulated DeLone and McLean model, have been updated since the termination of the study, the OSIS-value instrument can be updated to reflect the changes in the updates of these two models.

Thirdly, the OSIS-value instrument, as it currently stands, has to be validated. An important aspect during the validation process is the confirmation of the validity of the normalisation of the instrument scales. The Likert scale of the SEM of IS instrument was converted from a five-point scale to a seven-point scale, and the Likert scale of the Servqual instrument was converted from a nine-point scale to a seven-point scale to simplify the interpretation process.

Fourthly, the OSIS-value instrument, as it currently stands, also has to be verified. The instrument consists of four validated and verified questionnaires. However, in order for the OSIS-value instrument to be recognised as an instrument on its own, and to make sure that it does measure what the researcher wants it to measure, the instrument has to be verified.

Fifthly, after the OSIS-value instrument has been validated and verified, the actual evaluation process should be conducted. This will entail collection of data by means of stratified random sampling at the different "OSIS-units". Following that, the data should be captured and interpreted.

Finally, before the actual evaluation, some researchers might decide to construct a streamlined OSIS-value instrument, as some of the instruments have common characteristics. This might easily serve as a measuring instrument for the reformulated DeLone and McLean IS success model, because as far as the researcher could establish, there is no measuring instrument for the model.

6.6 SUMMARY

This study was prompted by the absence of an appropriate measuring instrument to measure the extent to which OSIS adds value to the SAAF. It was shown that an instrument could be developed to serve as the OSIS-value instrument. The study was concluded by proposing that the reformulated DeLone and McLean IS success model be used as framework for the OSIS-value instrument. This implied that a measuring instrument be chosen for each of the six dimensions of IS success, as defined by the model. The OSIS-value instrument, comprising of six different measuring instruments, is presented in Appendix B.

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APPENDIX A

INFORMATION CAPABILITIES

1. Information Technology Practices (ITP)

Capability

The capability of a company to effectively manage appropriate IT applications and infrastructure in support of operational decision making and communication processes.

IT for Operational Support

It includes the software, hardware, telecommunication networks and technical expertise to control business operations, to ensure that lower-skilled workers perform their responsibilities consistently and with high quality and to improve the efficiency of operations.

IT for Business Process Support

It focuses on the deployment of software, hardware, networks and technical expertise to facilitate the management of business processes and people across functions within the company and externally with suppliers and customers.

IT for Innovation Support

Includes the software, hardware, telecommunication networks and capabilities that facilitate people's creativity and that enable the exploration, development and sharing of new ideas. It also includes the hardware and software support to develop and introduce new products and services.

IT for Management Support

It includes the software, hardware, telecommunication networks and capabilities that facilitate executive decision making. It facilitates monitoring and analysis of internal and external business issues concerning knowledge sharing, market development, general business situation, market positioning, future market direction and business risk.

Table A-1: Information Technology Practices (Adapted from Marchand *et al.*, 2001b)

2. Information Management Practices (IMP)

Capability The capability of a company to manage information effectively over its life cycle.
Sensing Involves how information is detected and identified concerning: economic, social and political changes, competitors' innovations that might impact the business, market shifts and customer demands for new products, anticipated problems with suppliers and partners.
Collecting Consists of the systematic process of gathering relevant information by profiling information needs of employees; developing filter mechanisms to prevent information overload; providing access to existing collective knowledge and training and rewarding employees for accurately and completely collecting information for which they are responsible.
Organising Includes indexing, classifying and linking information and databases together to provide access within and across business units and functions as well as training and rewarding employees for accurately and completely organising information for which they are responsible.
Processing Useful knowledge consists of accessing and analysing appropriate information sources and databases before business decisions are made. Hiring, training, evaluating and rewarding people with analytical skills are essential for processing information into useful knowledge.
Maintaining Involves reusing existing information to avoid collecting the same information again, updating information databases so that they remain current and refreshing data to ensure that people are using the best information available.

Table A-2: Information Management Practices (Adapted from Marchand *et al.*, 2001b)

3. Information Behaviour and Values (IBV)

Capability

The capability of a company to instil and promote behaviours and values in its people for effective use of information.

Integrity

An organisational value manifested through individual behaviour that is characterised by the absence of manipulating information for personal gains such as knowingly passing on inaccurate information, distributing information to justify decisions after the fact or keeping information to oneself. Good information integrity results in effective sharing of sensitive information.

Formality

It refers to the degree to which members of an organisation use and trust formal sources of information. Depending on the size, virtualness and geographic dispersion of an organisation, this balance shifts toward more formal or informal information behaviour.

Control

It is the disclosure of information about business performance to all employees to influence and direct individual and subsequent company performance.

Sharing

It is the free exchange of non-sensitive and sensitive information. Sharing occurs between individuals in teams, across functional boundaries and across organisational boundaries.

Transparency

An organisation is "information transparent" when its members trust each other enough to talk about failures, errors and mistakes in an open and constructive manner and without fear of unfair repercussions.

Proactiveness

An organisation is called "information proactive" when its members actively seek out and respond to changes in their competitive environment and think about how to use this information to enhance existing and create new products and services.

Table A-3: Information Behaviour and Values (Adapted from Marchand *et al.*, 2001b)

APPENDIX B

THE OSIS-VALUE QUESTIONNAIRE

Background:

The questionnaire is based on the framework of the Reformulated DeLone and McLean Information System Success Model, see figure B-1 below. Each of the six IS success dimensions is measured by at least one measuring instrument. Table B-1 presents a summary of the outline of the questionnaire. The questionnaire is divided into four sections. All the questions are answered by using a seven point Likert scale.

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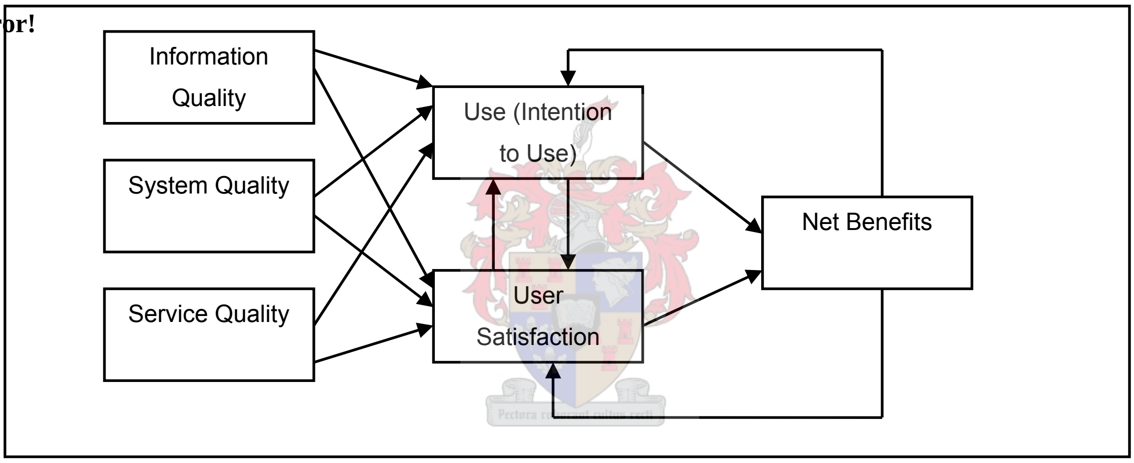

Figure B-1: The Reformulated IS Success Model (DeLone and McLean, 2002)

Table B-1: Summary of measuring instrument assigned to each success dimension

IS Success Dimension	**Measuring Instrument**
Information Quality	Computer User Satisfaction (Armstrong *et al.,* 2005)
System Quality	Task Technology Fit Model (Goodhue *et al.*, 2002) Computer User Satisfaction (Armstrong *et al.*, 2005)
Service Quality	Servqual (Kettinger, 1997)
Use/Intention to use	Task Technology Fit Model (Goodhue *et al.*, 2002)
User Satisfaction	Computer User Satisfaction (Armstrong *et al.*, 2005)
Net Benefits	MIS/DSS success measure (Sanders, 1984)

SECTION A: User Information Satisfaction Instrument for OSIS (Adapted from Armstrong *et al.*, 2005)

Instructions:

1. The UIS instrument contains 13 **items**, which is divided into 4 **groupings**.
2. Indicate, with a (x) the desired score for each item.
3. Obtain the mean of each grouping by adding all the item-means and dividing it by the number of items in that grouping.
   e.g. Grouping - Information Quality: (Mean_Item1 + Mean_Item2+ …. + Mean_Item 5)/5.
4. Fill out the data in the table at the end of Section A.
5. The data from the table at the end of section A, must then be consolidated with the other sections data in table B-2.

Scores per interval	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Strongly disagree			Neither			Strongly agree
1. Information Quality							
1. Information I get from OSIS is clear.							
2. OSIS is accurate.							
3. OSIS provides me with sufficient information							
4. OSIS provides me with up-to-date information							
5. OSIS provides reports that seem to be just about exactly what I need							
MEAN: CUS_IQ							
2. System Usefulness							
6. Using OSIS increases productivity.							
7. Using OSIS saves time.							
8. Using OSIS improves job performance.							
MEAN CUS_SU							
3. System Usage Characteristics							
9. OSIS is easy to use							
10. OSIS is easy to learn.							
11. It is easy to get OSIS to do what I want it to do.							
MEAN CUS_SUC							
4. Overall satisfaction							
12. OSIS meets the information processing needs of the business?							
13. I am mostly or always satisfied with OSIS?							
MEAN CUS_OS							

Section A: Consolidation

Variable	Mean	Std Dev	Minimum	Maximum
1. CUS_IQ			1.00	7.00
2. CUS_SU			1.00	7.00
3. CUS_SUC			1.00	7.00
4. CUS_OS			1.00	7.00

SECTION B: Measure of Task-System Fit (TSF) (Adapted from Goodhue and Thomson, 1995)

Instructions:

1. The TSF instrument contains 41 **items**, which is divided into 11 **groupings**.
2. Indicate, with a (x) the desired score for each item.
3. Obtain the mean of each grouping by adding all the item-means and dividing it by the number of items in that grouping.

   e.g. Grouping – TSF_Quality: (Mean_Item1 + Mean_Item2+ …. + Mean_Item 10)/10.
4. Fill out the data in the table at the end of Section B.
5. The data from the table at the end of section B, must then be consolidated with the other sections data in table B-2.

	1	2	3	4	5	6	7
	Strongly disagree			Neither			Strongly agree
A. TSF_Quality							
Currency: (Data that I use or would like to use is current enough to meet my needs.)							
1. OSIS does not require data that is current enough to meet my needs.							
2. OSIS's data is up to date enough for my purposes							
The Right Data: (Maintaining the necessary fields or elements of data.)							
3. The data maintained by the OSIS is pretty much what I need to carry out my tasks.							
4. OSIS is missing critical data that were very useful to me in my job.							
The Right Level of Detail: (Maintaining data at the right level or levels of detail.)							
5. OSIS maintains data at an appropriate level of detail for my group's tasks.							
6. Sufficiently detailed data is maintained by the OSIS.							
MEAN TSF_Q							
B. TSF_Locatability							
Locatability: (Ease of determining what data is available and where.)							
7. It is easy to find out what data OSIS maintains on a given subject.							
8. It is easy to locate corporate or divisional data on a particular issue, even if I haven't used that OSIS before.							
Meaning**:** (Ease of determining what a data element on a report or file means, or what is included or excluded in calculating it.)							
9. The exact definition of data fields, in OSIS, relating to my tasks is easy to find out.							
10. On OSIS and the reports produced by OSIS, the exact meaning of data elements is either obvious, or easy to find out.							
MEAN TSF_L							
C. TSF_Authorisation							
Authorisation: (Obtaining authorisation to access data necessary to do my job.)							
11. Data would be useful to me is unavailable because I don't have the right authorisation to access OSIS.							
12. Getting authorisation to access data on OSIS that would be useful in my job is time consuming and difficult.							
MEAN TSF_A							

Section B (cont.)

D. TSF_Compatibility							
Compatibility: (Data from different sources can be consolidated or compared without inconsistencies.)							
13. There are times when I find that supposedly equivalent data from two different sources is inconsistent.							
14. Sometimes it is difficult or impossible to compare or consolidate data from two different sources because the data is defined differently.							
15. When it's necessary to compare or consolidate data from different sources, I find that there may be unexpected or difficult inconsistencies.							
MEAN TSF_C							
E. TSF_Production Timeliness							
Timeliness: (OSIS meets pre-defined production turnaround schedules.)							
16. OSIS, to my knowledge, meets its production schedules such as report delivery and running scheduled jobs.							
17. Regular OSIS activities (such as printed report delivery or running schedule jobs) are completed on time.							
MEAN TSF_PT							
F. TSF_Systems Reliability							
Systems Reliability: (Dependability of access and up-time of OSIS							
18. I can count on OSIS to be "up" and available when I need it.							
19.OSIS is subjected to unexpected or inconvenient down times, which makes it harder to do my work.							
20. OSIS is subject to frequent system problems and crashes.							
MEAN TSF_SR							
G. TSF_Ease of Use/ Training							
Ease of Use of Hardware and Software: (Ease of doing what I want to do using OSIS hardware and software for submitting, accessing, and analysing data.)							
21. It is easy to learn how to use OSIS.							
22. OSIS is convenient and easy to use.							
Training: (Can I get the kind of quality OSIS-related training when I need it?)							
23. There is not enough training for me or my staff on how to find, understand, access or use OSIS.							
24. I am getting the training I need to be able to use OSIS's languages, procedures and data effectively.							
MEAN TSF_EoU/T							
H. TSF_Relationship with Users							
Is Understanding of Business: (How well does OSIS staff understand my unit's business mission and its relation to corporate objectives?)							
25. The OSIS people we deal with understand the day-to-day objectives of my work group and its mission within our company.							
26. My work group feels that OSIS personnel can communicate with us in familiar business terms that are consistent.							
OSIS staff interest and dedication: (To supporting customer business needs.)							
27. OSIS staff takes my business group's business problems seriously.							
28. OSIS staff takes a real interest in helping me solve my business problems.							
Responsiveness: (Turnaround time for a request submitted for OSIS services.)							
29. It often takes too long for OSIS staff to communicate with me on my requests.							
30. I generally know what happens to my request for OSIS services or assistance or whether it is being acted upon.							
31. When I make a request for service or assistance, OSIS staff normally responds to my request in a timely manner.							

Section B (cont.)

Consulting: (Availability and quality of technical and business planning assistance for OSIS.)							
32. Based on my previous experience I would use OSIS technical and business planning consulting services in the future if I had a need.							
33. I am satisfied with the level of technical and business planning consulting expertise I receive from OSIS staff.							
OSIS staff performance: (How well does OSIS staff keep their agreements?)							
34. OSIS staff delivers agreed-upon solutions to support my business needs.							
MEAN TSF_RWU							
I. TSF_Task Equivocally:							
35. I frequently deal with ill-defined business problems.							
36. I frequently deal with ad-hoc, non-routine business problems.							
37. Frequently the business problems I work on involve answering questions that have never been asked in quite that form before.							
MEAN TSF_TE							
J. TSF_Task Interdependence:							
38. The business problems I deal with frequently involve more than one business function.							
39. The problems I deal with frequently involve more than one business function.							
MEAN TSF_TI							
K. TSF_Performance Impact of OSIS							
40. OSIS has a large, positive impact on my effectiveness and productivity in my job							
41. OSIS and OSIS services are in important and valuable aid to me in the performance of my job.							
MEAN TSF_PI							

Section B: Consolidation

Variable	Mean	Std Dev	Minimum	Maximum
1. TSF_Q			1.00	7.00
2. TSF_L			1.00	7.00
3. TSF_A			1.00	7.00
4. TSF_C			1.00	7.00
5. TSF_T			1.00	7.00
6. TSF_SR			1.00	7.00
7. TSF_EoU/T			1.00	7.00
8. TSF_RwU			1.00	7.00
9. TSF_TE			1.00	7.00
10. TSF_TI			1.00	7.00
11. TSF_PI			1.00	7.00

SECTION C: IS Service Quality Instrument (Adapted from Kettinger and Lee, 1997)

Instructions:

1. The Servqual instrument contains 13 **items**, which is divided into 4 **groupings**.
2. Indicate, with a (x) the desired score for each item.
3. Obtain the mean of each grouping by adding all the item-means and dividing it by the number of items in that grouping.
   e.g. Grouping – Servql_Reliability: (Mean_Item1 + Mean_Item2+ Mean_Item 3)/3.
4. Fill out the data in the table at the end of Section C.
5. Use the information in the previous table, to consolidate all the data in the table B-2.

	1	2	3	4	5	6	7
	Low			Neither			High
A. Reliability							
1. When OSIS staff promises to do something by a certain time, they will do so.							
2. OSIS staff will perform the service right the first time.							
3. OSIS staff will provide their services at the time they promise to do so.							
MEAN SERVQL_Rel							
Responsiveness							
4. OSIS staff will give prompt service to users.							
5. OSIS staff will always be willing to help users.							
6. OSIS staff will never be too busy to respond to users' requests.							
MEAN SERVQL_Rel							
Assurance							
7. The behaviour of OSIS staff will instil confidence in users.							
8. OSIS staff will be consistently courteous with users.							
9. OSIS staff will have the knowledge to answer the users' questions.							
MEAN SERVQL_Ass							
Empathy							
10. OSIS staff will give users individual attention.							
11. OSIS staff will have employees who give users personal attention.							
12. OSIS staff will have the user's best interest at heart.							
13. OSIS staff will understand the specific needs of their users.							
MEAN SERVQL_Emp							

Section C: Consolidation

Variable	Mean	Std Dev	Minimum	Maximum
1. SERVQL_Res_P			1.00	7.00
2. SERVQL_Rel_P			1.00	7.00
3. SERVQL_Ass_P			1.00	7.00
4. SERVQL_Emp_P			1.00	7.00

Section D: MIS/DSS Success Measure (Adapted from Sanders, 1984)

Instructions:

1. The MIS/DSS instrument contains 13 **items**, which is divided into 2 **groupings**.
2. Indicate, with a (x) the desired score for each item.
3. Obtain the mean of each grouping by adding all the item-means and dividing it by the number of items in that grouping. (If the grouping has only one item, then the item mean will also be the grouping mean).
   e.g. Grouping – Perceived Usefulness: (Mean_Item1 + Mean_Item2+ …. + Mean_Item 6)/6.
4. Fill out the data in the table at the end of Section D.
5. Use the information in the previous table, to consolidate all the data in the table B-2.

	1	2	3	4	5	6	7
	Strongly disagree			Neither			Strongly agree
A. Perceived Usefulness							
1. I have become dependent on OSIS.							
2. As a result of OSIS, I am seen as more valuable in this organisation.							
3. I have come to rely on OSIS in performing my job.							
4. All in all I think that OSIS is an important system for this organisation.							
5. OSIS is extremely useful.							
6. I personally benefited from the existence of OSIS in this organisation.							
MEAN_DSS_PU							
B. Decision Making Satisfaction							
7. Utilisation of OSIS has enabled me to make better decision.							
8. As a result of OSIS, I am better able to set my priorities in decision making.							
9. Use of data generated by OSIS has enabled me to present my arguments more convincingly.							
10. OSIS has improved the quality of decisions I make in this organisation.							
11. As a result of OSIS, the speed at which I analyse decisions has increased.							
12. As a result of OSIS, more relevant information has been available to me for decision-making.							
13. OSIS has lead me to greater use of analytical aids in my decision making.							
MEAN_DSS_DMS							

<u>Section D: Consolidation</u>

Variable	Mean	Std Dev	Minimum	Maximum
1. DSS_PU			1.00	7.00
2. DSS_DMS			1.00	7.00

OSIS-value instrument Interpretation

Table B-2 presents the consolidated data of the OSIS-value questionnaire. It should be noted that the first three items in table B-2, is that that have common characteristics. The mean of the common characteristics is then obtained a presented in the last column of the table. The last column in table B-2 contains dummy data as explanation of the graphical representation (figure B-2) of the OSIS-value questionnaire. Figure B-2 indicates for example that the perception of the users is that the information quality of OSIS is quite high; OSIS is deemed useful but they are indecisive regarding the ease of use of OSIS. Thus, it is an area that might need attention from management's side.

Table B-2: OSIS-value instrument interpretation

Legend	**Characteristic**	**Calculation**	Total Mean
IQ	Information Quality	(CUS_IQ + TTF_IQ)/2	6
SU	System Usefulness	(CUS_SU + MIS_SU)/2	5
EoU	System Ease of Use	(CUS_SUC + TTF_EoU)/2	4
OS	Users' Overall Satisfaction with System	CUS_OS	4
Time	Timeliness of Information	TTF_T	3
Loca	Locatability of information	TTF_L	2
Auth	Authorization for system use	TTF_A	4
Comp	Compatibility of system	TTF_C	3
RwU	Relationship with users by IS service staff	TTF_RwU	5
TC	Task characteristics	TTF_TC	4
TE	Task Equivocally	TTF_TE	5
TI	Task Interdependence	TTF_TI	6
IP	Individual Performance impact using the system	TTF_IP	5
Rel	Reliability of IS Service Quality rendered	SERVQL_Rel_P	5
Res	Responsiveness of IS Service Quality staff	SERVQL_Res_P	6
Ass	Assurance of IS Service Quality staff	SERVQL_Ass_P	3
Emp	Empathy of IS Service Quality staff	SERVQL_Emp_P	3
DMS	Decision making satisfaction	DSS_DMS	6

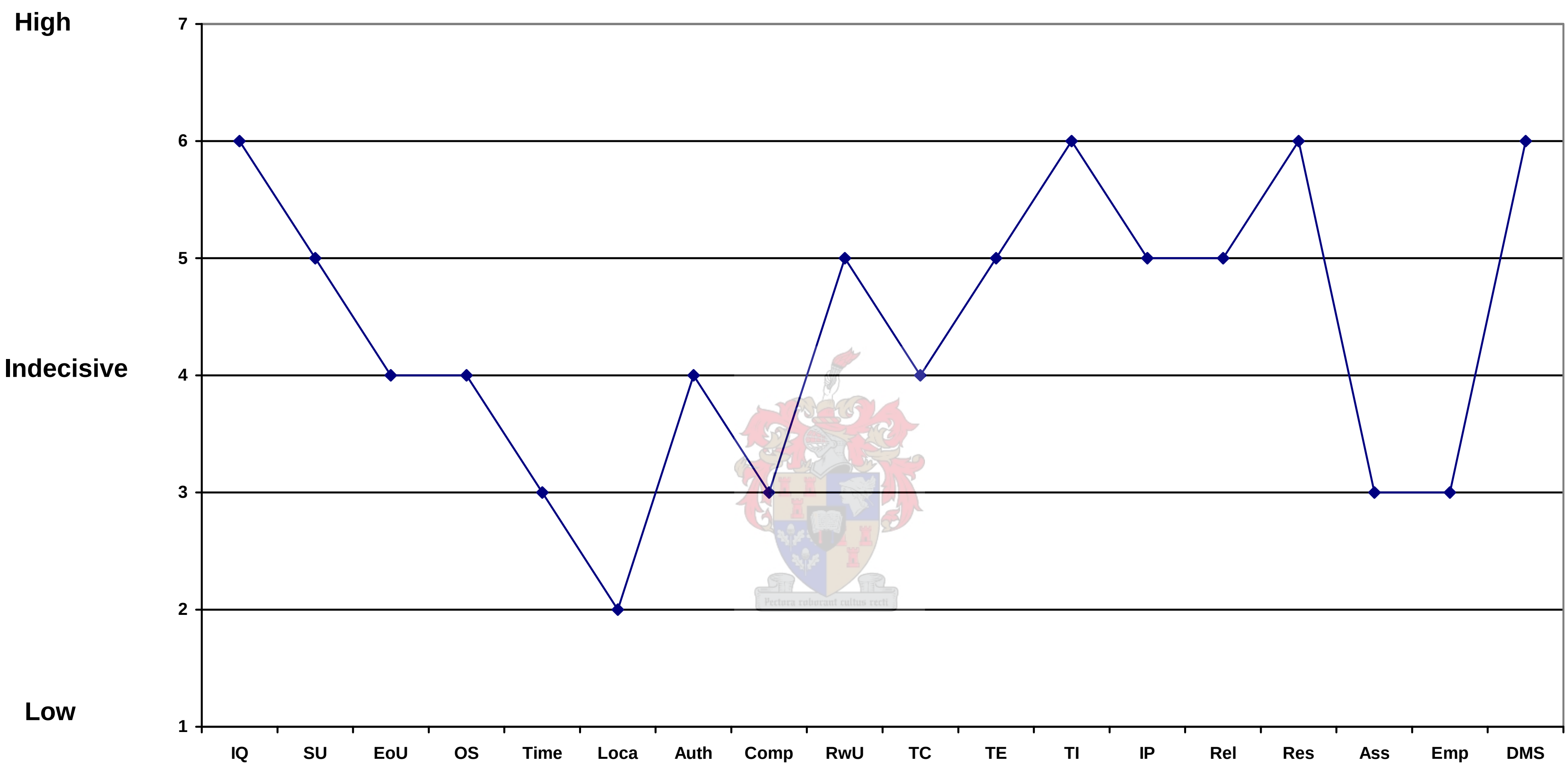

Figure B-2: OSIS-value instrument