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THE CRITICAL SUCCESS FACTORS FOR IMPLEMENTING DATA WAREHOUSE BASED EXECUTIVE INFORMATION SYSTEMS

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Research dissertation in partial fulfillment of the requirements for the degree of Master of Commerce, submitted to:

Faculty of Commerce
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Johannesburg
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August 1998

ABSTRACT

The use of Information Technology to meet the information needs of senior business executives has been the focus of research effort for many years. Some years ago the emergence of Executive Information Systems (EISs) was seen as the panacea for the information needs of senior executives. More recently, Data Warehouses have been lauded as the ideal technology for providing an integrated view of an organisation's data, while allowing analysis to be performed on this data. Data Warehouses are seen as the ideal vehicle for decision support and the provision of executive information. However, research studies have shown that the failure rate of both EISs and Data Warehouses are very high.

This research identifies, from a theoretical and practical business perspective, those critical factors that contribute to the successful implementation of EISs based on Data Warehouses. This research is aimed primarily at senior business managers and executives, IS/IT managers, and Data Warehouse practitioners, but is also relevant to researchers. The Critical Success Factors (CSFs) can serve as indicators of potential risk, as variables for consideration during planning and management, as a basis for judging the suitability of EISs based on Data Warehouses in particular situations, and as a basis for justifying an investment in Data Warehousing.

Chapter one introduces the concepts of EISs and Data Warehousing. It also discusses the high rate of failure of EIS and Data Warehouse implementations, the need for understanding the CSFs for implementing EISs based on Data Warehouses, and accounts for the justification of this research. Chapter two critically examines recent literature on EISs and Data Warehouses, and the critical issues surrounding the implementation of EISs based on Data Warehouses. The results of the literature review are presented as a narrative description that is synthesised to develop the theoretical conjecture and associated empirical generalisations for the research. Chapter three develops an argument for the research approach adopted, and presents the research methodology, or procedural framework, within which the research was conducted. Research evidence was gathered by conducting eighteen semi-structured interviews with senior business and IS/IT managers, and Data Warehouse practitioners. Chapter four presents the results of the content and interpretive analysis that was conducted on the research evidence. Chapter five reviews the research results against the aim and objectives of the research, and against the theoretical conjecture and empirical generalisations. Based on the results of the review a refined theoretical conjecture is proposed. Chapter six highlights some of the limitations of the research, and provides suggestions for further research.

Keywords: *critical success factors, executive information systems, data warehouse, data warehousing*

DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Commerce at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.

S.M. Bestbier

Stuart Bestbier

4th day of August 1998.

ACKNOWLEDGEMENTS

I would like to express my sincerest thanks and gratitude to my wife, Regina, for her for her unfailing support, love and understanding. In addition to managing our impending move overseas, and having to meet her own pressing commitments, she has made it possible to endure what has become a very challenging year. This dissertation simply would not have been possible without her.

I would also like to thank all the respondents who gave up their valuable time to be interviewed.

Finally, I would like to express my thanks to my supervisors, Alison Heafield and Ian Steer, for their patience, commitment and input. In particular, I would like to thank Ian, who, in addition to providing me with encouragement, valuable assistance, and much needed guidance, managed to do so in a time frame that allowed me to meet seemingly impossible deadlines.

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CHAPTER ONE: INTRODUCTION

1.1 Introduction

The destiny of organisations in the 1990s is being shaped by a number of significant business forces that include pressure to continuously improve productivity and efficiency, a rapidly increasing growth in globalisation and associated worldwide competition, and a volatile business environment (Madnick, 1991). Drucker (1995) observes that the majority of businesses potentially face global competition from places they have not even heard of before.

Relevant, timely access to information to sense changes in the external environment and stay in close touch with the organisation and its members is crucial to the organisational direction setting process (Scott Morton, 1991). The effectiveness of this direction setting will determine whether senior executives can ensure sustainable competitiveness in the face of the various business forces (Young and Watson, 1995).

The use of Information Technology (IT)[1] to meet the information needs or assist and guide the strategic decisions of senior business executives has been the focus of research effort for many years (Ackoff, 1967; Rockart and Treacy, 1982; Watson *et al.*, 1991; Fitzgerald and Murphy, 1994; Nord and Nord, 1995). Despite this research effort and the development of numerous computerised Information Systems (IS)[2] aimed specifically at the perceived needs of senior executives, these executives have remained largely untouched (and unimpressed) by these initiatives (Mintzberg, 1975; Gorry and Scott Morton, 1989; Rees-Evans, 1989; Watson and Kelly Rainer, 1991; Fitzgerald and Murphy, 1994; Ward and Griffiths, 1996). This is because these information systems do not meet executive needs for quick, easy access to relevant, timely, and accurate information (Watson and Kelly Rainer, 1991; Wetherbe, 1991). Researchers and developers alike have regarded the emergence of Executive Information Systems (EISs) as the latest panacea for the information and decision-making needs of senior executives. This is because the fundamental motivation for developing this type of information system is to provide executives with only the information they need (Watson and Kelly Rainer, 1991). However, research studies have shown that more than fifty percent of EIS implementations are regarded as failures (Fitzgerald and Murphy, 1994).

The last few years have also seen the emergence of the Data Warehouse. Data Warehouses have been widely lauded as the ideal technology for providing an integrated view of an organisation's data, while allowing various analyses to be performed without placing the data or their underlying operational systems at risk. Vendors have lost no

[1] **Information Technology** represents the *supply* of technology products and services and their application in the delivery of information and systems, in response to business information needs (Butler Cox Foundation, 1991; Ward and Griffiths, 1996).

[2] **Information Systems** represent the *demand* for information, systems, and technology and the management of applications from a business perspective, in support of business information needs (Butler Cox Foundation, 1991; Ward and Griffiths, 1996).

time extolling the virtues of using Data Warehouses and their associated tools as an architecture for decision support and the provision of executive information (McElreath, 1995). There has been rapid and widespread adoption of the technology, and most organisations that have not yet implemented a Data Warehouse are considering doing so (McElreath, 1995; Chang and Fergusen, 1996; Kelley, 1997). Despite unprecedented business value being achieved by some implementations, Kelley (1997) reports that:

> "...sixty percent of all Data Warehouse projects in Europe fail."

This research is aimed at obtaining a greater understanding of the factors that contribute to the success of EISs based on Data Warehouses.

Chapter one introduces the concepts of EISs and Data Warehousing. It also discusses the high rate of failure of EIS and Data Warehouse implementations, the need for understanding the CSFs for implementing EISs based on Data Warehouses, and accounts for the justification of this research. Chapter two critically examines recent literature on EISs and Data Warehouses, and the critical issues surrounding the implementation of EISs based on Data Warehouses. The results of the literature review are presented as a narrative description that is synthesised to develop the theoretical conjecture and associated empirical generalisations for the research. Chapter three develops an argument for the research approach adopted, and presents the research methodology. Research evidence was gathered by conducting eighteen semi-structured interviews with senior business and IS/IT managers, and Data Warehouse practitioners. Chapter four presents the results of the content and interpretive analysis that was conducted on the research evidence. Chapter five reviews the research results against the aim and objectives of the research, and against the theoretical conjecture and empirical generalisations. Chapter six highlights some of the limitations of the research, and provides suggestions for further research.

1.2 Executive Information Systems and Data Warehousing in Context

1.2.1 The evolving use of IS/IT

The use of computers in business started in the early 1950s but only became significant in the mid-1960s with the development of mainframes (Ward and Griffiths, 1996). This use has 'evolved' from the automation of repetitive tasks to the strategic use of IS/IT for competitive advantage.

Various models have been used to describe the role of IS/IT and their past and expected future evolution. However, early models such as the one developed by Gibson and Nolan (1974) and Nolan (1979) were based strongly on the centralised integrated concept derived from the mainframe paradigm (Anthony, 1965; Gibson and Nolan, 1974; Nolan 1979; Ward and Griffiths, 1996). As the practical limitations of the early models became apparent researchers challenged their simplicity and underlying assumptions (Drury, 1983; King and Kraemer, 1984). Ward and Griffiths (1996) observe that although the

Nolan model is useful it does not adequately describe the evolution of IS/IT since the mid 1970s. It also does not cater for the identification or explanation of opportunities for the strategic use of IS/IT. However, despite their weaknesses the models significantly influenced management thinking until recently. Based on these findings a 'three era model' has more recently been proposed to describe the evolution of the use of IS/IT in organisations (Wiseman, 1985; Galliers and Somogyi, 1987; Ward and Griffiths, 1996) (Figure 1.1). The model divides the evolution of IS/IT into three distinct but overlapping eras: The Data Processing (DP) era, the Management Information System (MIS) era, and the Strategic Information System (SIS) era. The model shows the three eras as separate and distinct but this is a conceptual simplification. Although the objectives of using IS/IT differ for each era, SISs depend on a good foundation of MISs and DP systems for success. Therefore, an organisation that has evolved through the eras and has a portfolio of SISs will also have a good foundation of DP and MISs. The DP era is still very much with us and as Ward and Griffiths (1996) put it:

> "Many organisations have yet to emerge successfully from the problems of the first two eras [and] a considerable part of future investment will be in DP and MISs."

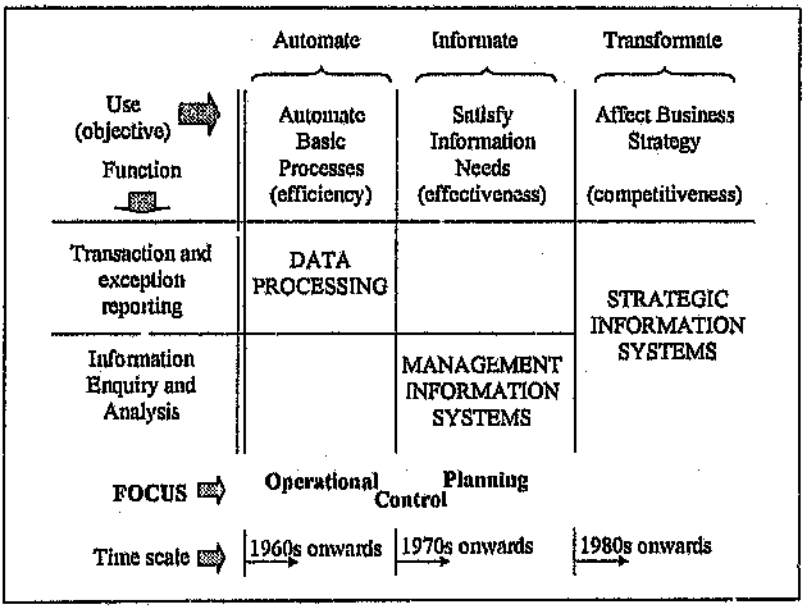


Figure 1.1 The 'three eras' in the evolution of the use of IS/IT (adapted from Ward and Griffiths, 1996)

1.2.2 The Data Processing era

The DP era, or 'automate' stage of IS/IT usage started in the 1960s. Systems in this stage of evolution focus on improving operational efficiency and improving performance by automating information based processes, and their use is directed primarily at operators and clerical staff (Zuboff, 1988; Ward and Griffiths, 1996; Orr, 1997). Although these types of systems often generate information as a by-product little or no use is made of this information beyond direct control of the existing process (Scott Morton, 1991). Systems in this era represent the less glamorous use of IS/IT but they still remain important and continually improving hardware and software technology is being used extensively to improve the automation of processes. Ward and Griffiths (1996) predict that:

> "Even in the future perhaps more than fifty percent of all IS/IT investments will be about improving efficiency."

1.2.3 The Management Information Systems era

By the mid 1970s ways of developing successful operational systems were well established. The data stored in computers and the technology available to access it made improved decisions possible through the availability of management information - the MIS era, or 'informate' stage of IS/IT usage had started (Zuboff, 1988; Scott Morton, 1991; Ward and Griffiths, 1996; Orr, 1997). Systems in this stage of evolution focus on increasing management effectiveness by satisfying their information requirements with the objective of allowing effective problem resolution and support for decision making, and their use is directed at professionals and middle to senior managers. IS/IT had now evolved to include enquiry and analysis functionality and tended to be characteristic of control and planning systems rather than operational systems (Ward and Griffiths, 1996).

Together with new opportunities this era brought with it a number of significant issues. Managers were now required to understand the value and potential use of the information now available to them (Scott Morton, 1991). Furthermore, traditional requirements gathering approaches were no longer valid as the decision making processes of managers tend to be unstructured and unpredictable (Mintzberg, 1975; Gorry and Scott Morton, 1989; Watson and Frolick, 1993; Nord and Nord, 1995). Also, since the benefits from these systems, such as the effectiveness improvement of managers resulting from improved access to information, tend to be intangible they are difficult to measure, aggregate, and value (Brynjolfsson, 1994a; Brynjolfsson, 1994b; Wagner, 1996).

1.2.4 The Strategic Information Systems era

The 1980s saw the beginning of the SIS era or 'transformate' stage of IS/IT usage, the third in the evolution of the use of IS/IT (Scott Morton, 1991; Ward and Griffiths, 1996). Systems in this stage of evolution focus on improved competitiveness by fundamentally

changing the nature or conduct of business. These systems are not intrinsically different from DP or MISs, but their impact on the business is (Ward and Griffiths, 1996).

Based on a research base of over 150 examples, Ward and Griffiths (1996) found that there appear to be four types of strategic systems:

1. Those that share information with their customers and or suppliers and change the nature of the relationship;
2. Those that produce more effective integration of the use of information in the organisation's value adding process;
3. Those that enable the organisation to develop, produce, market and deliver new or enhanced products or services based on information; and
4. EISs that provide executive management with information to support the development and implementation of strategy. This type of application represents the smallest number of examples and has only been made possible by recent developments in external business databases and the potential offered by knowledge based systems.

1.2.5 Where do Executive Information Systems fit in?

EISs are computerised systems that provide top management with easy access to internal and external information that is relevant to their Critical Success Factors (CSFs) or Key Performance Indicators (Rees-Evans, 1989; Watson and Kelly Rainer, 1991; Watson *et al.*, 1991; Millet and Mawhinney, 1992; Fitzgerald and Murphy, 1994; Nord and Nord, 1995; Ward and Griffiths, 1996). Millet and Mawhinney (1992) define an EIS to be:

> "...a system that integrates information from internal and external data sources enabling executives to monitor and request information of key importance to them via customised presentation formats."

Walstrom and Wilson (1997) and Young and Watson (1995) broadly define an EIS to be a computerised system that provides executives with information that is relevant to their work, while Overton, *et al.* (1996) define it to be a system that provides access to high-level strategic information about a firm's current status.

EISs have the defining characteristics listed below. They (Watson and Kelly Rainer, 1991; Watson *et al.*, 1991; Matthews and Shoebridge, 1992; Fitzgerald and Murphy, 1994; Kelly, 1994; Young and Watson, 1995; Haley and Watson, 1996; Walstrom and Wilson, 1997):

- Are tailored to executives' information needs;
- Extract, filter, compress, and track critical data;
- Report exception conditions to highlight variances;
- Provide on-line access, trend analysis, exception reporting and drill down;
- Access and integrate a broad range of internal and external data;
- Incorporate hard and soft data;

- Are user-friendly and require minimal or no training to use;
- Are used directly by executives; and
- Present graphical, tabular, and/or textual information.

The growth in usage of EISs has been attributed, on the one hand, to the diminishing cost of computer hardware and software (Rockart and Treacy, 1982; Watson *et al.*, 1991); the claim that executives are better informed of the availability and capabilities of new technologies (Rockart and Treacy, 1982); and the assertion that the volatile competitive business environment is fuelling the need for more timely access to better quality information (Rockart and Treacy, 1982; Watson *et al.*, 1991; Nord and Nord, 1995). Fitzgerald and Murphy (1994), on the other hand, argue that contrary to popular belief, EISs are being introduced into organisations based on IS department push and the availability of appropriate enabling technology, rather than due to the increased readiness of executives to make use of computers or the increasingly competitive nature of the business environment. They also found that executives were willing to support an EIS development out of fear that they may become marginalised if the use of an EIS became important and they did not have access to it.

In the context of the three era model discussed above EISs do not focus on improving operational efficiency and are not in themselves DP systems. However, to provide good quality information to executives for decision making purposes they draw strongly on a good infrastructure of DP systems and external data sources (Millet and Mawhinney, 1992). There is a strong overlap between the objectives of an EIS and the objectives of systems in the MIS era (Millet and Mawhinney, 1992). Furthermore, depending on what information is provided by an EIS and how managers use it, there is significant potential for it to influence strategy development. This in turn can lead to improved competitiveness by changing the nature or conduct of business. Therefore, an EIS may in some instances also be a SIS. The relative position of EISs in the continuum of evolution depicted by the three era model is shown in figure 1.2.

- ***The Difference Between, MISs, EISs, Decision Support Systems, and Executive Support Systems***

Although the terms are sometimes used interchangeably EISs are distinct from MISs, Decision Support Systems, and Executive Support Systems. The difference between MISs, EISs, and Decision Support Systems in terms of their primary purpose, users, output, operations and time orientation is shown in table 1.1. Decision Support Systems provide modeling capabilities as well as information retrieval capabilities (Fitzgerald and Murphy, 1994). Furthermore, they are designed for specific decision-making tasks and are most commonly used by operational staff, and middle and lower managers, rather than by senior executives (Watson *et al.*, 1991). Table 1.1 serves to provide a high level overview and to illustrate the key distinguishing features of these systems rather than to define mutually exclusive domains (Millet and Mawhinney, 1992).

An Executive Support System has a broader set of capabilities than an EIS and is seen to be a combination of an EIS with electronic communications and other executive work

station services, such as data analysis capabilities and organising tools (Watson and Kelly Rainer, 1991; Watson *et al.*, 1991; Millet and Mawhinney, 1992).

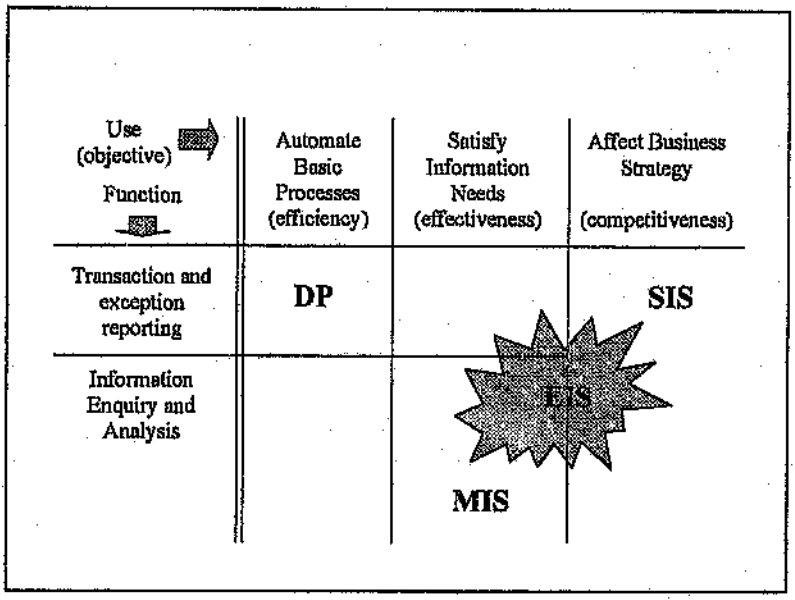


Figure 1.2 Executive Information Systems in relation to the three era model (adapted from Ward and Griffiths, 1996)

Table 1.1 The difference between MISs, EISs and Decision Support Systems (Millet and Mawhinney, 1992)

	Primary purpose	Primary users	Primary Output	Primary Operations	Time Orientation
MIS	Internal Monitoring	All Levels of Managers	Pre-defined Periodic Reports	Summarise Information	Past
EIS	Internal and External Monitoring	Executives	Pre-defined Customised Presentations	Integrate, Present, Track CSFs	Past to Present
DSS I	Support Structured Decisions	Clerical or Automated	Decisions	Solve, Model, Automate, Suggest	Present to Future
DSS II	Semi / Unstructured Decisions	Staff and Managers	Suggestions, Analytic Reports	Model, Solve, Suggest, Analyse	Future to Present

1.2.6 Where does Data Warehousing fit in?

William Inmon is credited with having coined the phrase *Data Warehouse* in 1990. Inmon, who is recognised as the 'father' of the Data Warehouse concept, defined it to be a managed database in which the data is subject-oriented, integrated, time variant, and non-volatile (Hackathorn, 1995, Lambert 1995a). According to Lambert (1995a) the goal of a Data Warehouse is to provide a single view of business reality for an organisation while Hackathorn (1995) believes a Data Warehouse is where business mar' 's can find the information they need to steer the business correctly. McElreath (199. .scribes a Data Warehouse as an EIS and/or Decision Support System with the express purpose of providing the information and tools to allow strategic analysis of information. Orr (1997) claims that a Data Warehouse can be described as an enterprise-wide framework for managing informational data within an organisation.

There are probably as many different definitions of a Data Warehouse as there are practitioners and authors on the subject and each definition depends on the background and perspective of the author. In general, however, most practitioners agree that a Data Warehouse, in its broadest sense, consists of three 'views' (Ely, 1997; Gaigher, 1997; Orr, 1997; Stone, 1997; Worseman, 1997) (Figure 1.3.):

- The IT or Operational View;
- The Heart of the Data Warehouse; and
- The Business View.

- ***The IT or Operational View***

Data Processing or operational systems and external data sources provide the data that is used to 'populate' the Data Warehouse (Hackathorn, 1995; Orr, 1997). Since these operational systems have historically been designed to improve the efficiency of specific functional areas such as order processing, they are often not integrated with other organisational systems and also often do not share a common or compatible architecture (Millet and Mawhinney, 1992). This makes a Data Warehouse a very attractive solution for solving the need for information that spans functional boundaries. However, the data structures of each of the external and operational systems may differ from one another and are usually optimised for transaction processing (Radding, 1996; Orr, 1997; Sahin, 1997). Therefore, the data from each of the source systems must be consolidated and 'transformed' into a format and structure that is optimised for ad hoc reporting and analysis, before it can be loaded into the Data Warehouse (McElreath, 1995; Hackathorn, 1995; Radding 1996). In the process of transformation the definition of each of the data elements must be clarified and the data elements must be loaded into the Data Warehouse in the format and level of detail required for the types of analysis and access likely to be performed (Hackathorn, 1995). The IT or operational view includes all the processes and procedures that must be performed to keep the data in the Data Warehouse up to date (Orr, 1997). These processes and procedures ensure that the required data is manually or automatically retrieved from source systems, transformed, and loaded into the Data Warehouse (Orr, 1997). The difference between operational or transactional data and Data Warehouse data is shown in table 1.2.

Table 1.2. The difference between operational data and Data Warehouse data (Porter and Rome, 1994; McElreath, 1995)

Operational Data	Data Warehouse Data
Continually updated	Read only
Short-lived, rapidly changing	Long-living, static
Requires record level access	Data is aggregated into sets
Repetitive standard transactions and access patterns - serves operational users	Ad hoc queries with some periodic reporting - serves management
Updated in real time	Updated periodically with mass loads
Event-driven: process generates data	Data driven: data governs process

- ***The Heart of the Data Warehouse***

Logically, the heart of the Data Warehouse is a store of the required views of operational data, optimised for flexible ad hoc reporting and analysis. Physically, the Data Warehouse can be made up from a variety of architectural configurations, from a dedicated database designed specifically for the purpose, to virtual functionally-oriented 'data marts' based on multidimensional databases (Orr, 1997). Whatever configuration is ultimately chosen normally depends on the type of reporting and analysis likely to be performed by the business as well as the volume of data to be stored (Orr, 1997). Each has its advantages and disadvantages and cost considerations. The underlying architecture should never be of any concern to the business, provided it can achieve the stated objectives within practical cost constraints.

- ***The Business View***

The business view is also referred to as the information access layer. This is the layer that the end user interacts with directly (Orr, 1997). It includes all the tools and techniques used by the end user to access, analyse and report on the data in the Data Warehouse (Hackathorn, 1995; Orr, 1997). Since the Data Warehouse can potentially contain very detailed good quality enterprise-wide data, as well as external data, it is well suited to a multitude of uses, including, but not limited to data mining, multidimensional analysis, data visualisation, the provision of executive information, and for decision support. A Data Warehouse is structured around data, rather than analytical queries so that the system can respond rapidly to unforeseeable queries (McElreath, 1995; Fisher, 1996). This is because analytical queries are rarely defined in advance and, as Fisher (1996) puts it:

> "The first question an analyst asks is rarely the right one to get the answer desired."

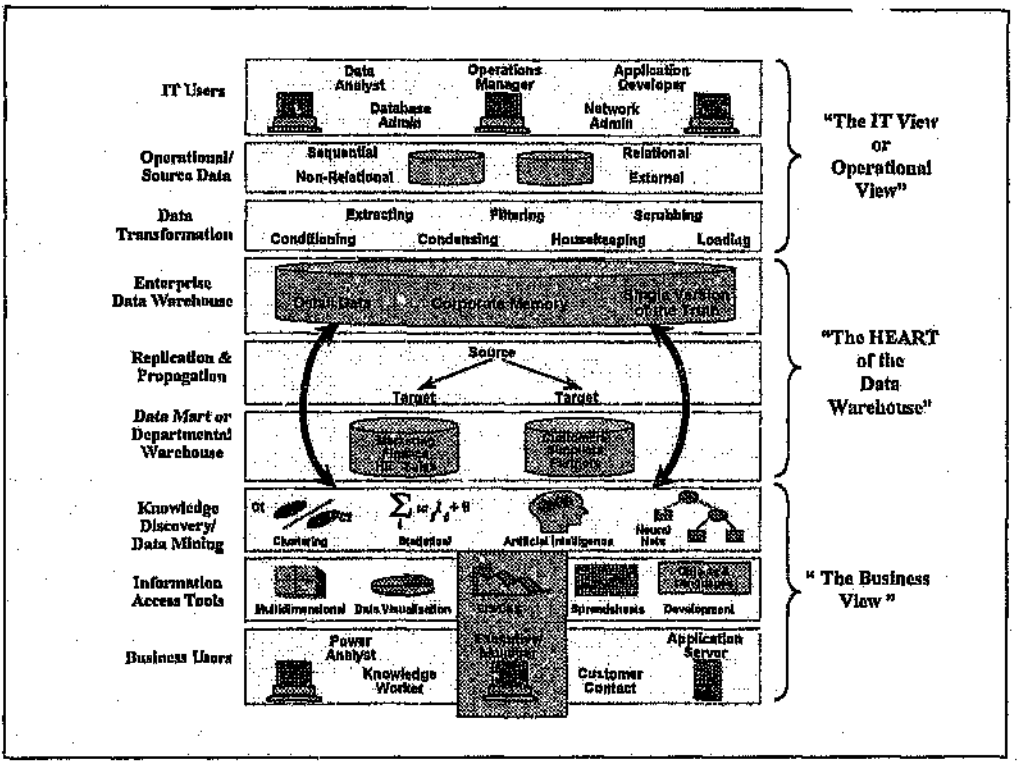


Figure 1.3 The three Data Warehouse 'views'

- ***An Architectural Concept***

Although a comprehensive Data Warehouse solution consists of a number of technical and business components its value resides in how the business uses the data it makes available. It can potentially provide summarised and detailed data on all aspects of the organisation, its competitors, and its marketplace, to staff at all levels of the organisation (Hackathorn, 1995). Furthermore, it can provide flexible access to current and historical data to senior executives so that they can keep track of the key performance areas and indicators of the business, with the ability to drill down into the required supporting detail when they need to.

A Data Warehouse is therefore a holistic architectural concept rather than a product or a specific solution to a specific information need (Freeman, 1997). It is a tool that can be an asset to an organisation that has the ability to manage its information resource. It can also be a liability to an organisation that has yet to embrace the importance of its information and how to manage it. As Worseman (1997) puts it:

> "A Data Warehouse is NOT a solution to the demand for information, it is merely an enabling technology"

- *Metadata*

An important component of a Data Warehouse is one that spans the three views discussed above. This is the data directory or metadata layer. A Data Warehouse is only complete if it contains definitions and descriptions of where the data is located, what is represents, and where it came from, from both user and IS/IT perspectives (McElreath, 1995; DeJesus, 1995; Hackathorn, 1995; Orr, 1997).

1.3 The Need for Understanding the Critical Success Factors

1.3.1 What is a Critical Success Factor?

CSFs are those few key areas where 'things must go right' to ensure success (Guynes and Vanecek, 1996; Ward and Griffiths, 1996).

1.3.2 The need for understanding the Critical Success Factors

With the transition from the industrial age to the information age organisations are leveraging information about their processes, products, services, customers and markets to exploit opportunities and gain advantage over their competitors. There is an increasing realisation that information has value, that it is an asset, and that it must be managed as a resource (Earl, 1996). To realise its value, information must be collected, recorded, stored, processed, manipulated, transmitted, delivered, and presented. Information also has a life expectancy, usually depreciates and can become obsolete (Glazer, 1993).

EISs have emerged as a favoured solution for providing executives and senior managers with the information they require for decision making, and are being implemented in a growing number of organisations (Watson *et al*, 1991; Matthews and Shoebridge, 1992; Millet and Mawhinney, 1992; Watson and Frolick 1993; Fitzgerald and Murphy, 1994). Overton, *et al.* (1996) claims that:

> "One of the most significant trends in the field of information systems is the increasing prevalence of Executive Information Systems."

According to Wetherbe (1991) one of the reasons for this is that failure to get executives the information they need in a timely manner can result in lost opportunities or in a problem not being solved in time.

EISs are expensive to develop and maintain. A study in 1988 of large organisations in the USA and Canada by Watson and Kelly Rainer (1991) found that the average cost of developing an EIS at that time was $US 365,000 and the average annual cost of maintaining one was $US 208,000. Despite the costs involved there is a growing interest in EISs. In 1992 the EIS market was estimated to be worth more than $100 million world wide, was growing at over thirty percent per annum, and was expected to continue growing at forty percent per annum (Matthews and Shoebridge, 1992). Watson *et al.*,

(1991) quote International Data Corporation (IDC) as predicting that the US market for EISs was growing at a compound annual rate of nearly forty percent in 1991. According to Nord and Nord (1995) IDC also predicted that EIS software sales would reach $230 million in 1995 and that the US market would still be growing at a compound annual rate of nearly forty percent.

EISs are challenging to develop. Although there is a growing body of knowledge about EISs and there have been some successful implementations, there are still a large number of failures and they remain high risk, expensive systems (Watson *et al.*, 1991; Matthews and Shoebridge 1992; Millet and Mawhinney, 1992; Watson and Frolick, 1993; Fitzgerald and Murphy, 1994; Young and Watson, 1995; Walstrom and Wilson, 1997). According to Walstrom and Wilson (1997):

> "...because an EIS is a top management tool, its development is a high profile, high-risk endeavor."

In one study forty two percent of the respondents reported an EIS failure prior to the development of a successful system (Watson and Frolick, 1993). Millet and Mawhinney (1992) report that experts claim that almost twenty five percent of the EIS installations they were aware of were failures.

Data Warehouses contain the data that form the information base for decision making, and most organisations expect them to provide the following benefits (Chang and Fergusen, 1996):

- The ability to understand trends in the business;
- The ability to deliver relevant information for timely decisions; and
- The ability to use information for more intelligent marketing and targeting.

However, the realisation of these specific business benefits has fallen short of expectations. Instead, organisations are realising other unexpected benefits in the form of the ability to obtain a competitive edge, and the ability to improve the quality of the products or services they offer (Chang and Fergusen, 1996).

Data Warehouse projects are not easy or predictable (Fisher, 1996; Griffin, 1998). Most initial Data Warehouse implementations fail and although exact figures are not readily available it is estimated that these figures are between forty and seventy percent (Hackney, 1997). Since enterprise Data Warehouses cross functional, empire, political, process and ownership boundaries they are inherently high risk and have a low probability for success (Hackney, 1997). This is also why their success is less dependent on technology than it is on the cultural and political issues surrounding information management and information ownership (Hackathorn, 1995; Horrocks, 1995; Cafasso, 1996; Fisher, 1996). Hackney (1997) supports this view by claiming that the overwhelming cause of failure is the result of human, rather than technology issues. This view is further supported by Griffin (1998) and Madsen (1997) who claim that Data Warehouses are business projects, not technology projects and that technology alone, no matter how sophisticated, will not ensure success. McElreath (1995) cautions that with

Data Warehousing, especially for large volumes of data, the pitfalls and opportunities for disappointment are substantial.

Demarest (1997) claims that the Data Warehousing marketplace understates actual cases of Data Warehouse failures. He also observes that there is a lack of normative and prescriptive information on techniques to help practitioners avoid project failure. According to Demarest (1997) practitioners are not sharing their experiences regarding the type of complexity involved in Data Warehousing, why Data Warehouse projects fail, and what can be done to prevent failures.

Despite the low success rate, high risk and vast differences in returns reported, most large companies have installed Data Warehouses, or are in the process of doing so (Fisher, 1996). Fisher (1996) and McElreath (1995) claim that according to the Meta Group, ninety percent of all large companies are implementing Data Warehouses. Chang and Fergusen (1996) claim that sixty percent of larger organisations are considering implementing Data Warehouses or have already done so. The market for Data Warehousing is estimated to be between $US 8 billion and $US 12 billion in size (Hackney, 1997).

The high cost, high risk, and high failure rate of both EISs and Data Warehouses points to a compelling need for a critical perspective and better understanding of the factors that contribute to the successful implementation of EISs based on Data Warehouses.

1.4 Statement of the Problem

A research problem is the center around which the research effort turns. It must be clearly and concisely expressed and be divided into manageable sub-problems. In so doing it provides clarity on the goal and direction of the entire research effort (Leedy, 1997).

1.4.1 The research problem and research question

In the context of the significant interest in EISs and Data Warehouses, and the high risk and high costs associated with these types of projects, this research is centered on the research *problem* stated below:

This research will analyse Data Warehouse implementations in South Africa that have been used for executive information purposes, to establish those factors that must be achieved, as an absolute minimum, to ensure the successful implementation of EISs based on Data Warehouses.

The research problem translates into the following research *question*:

What are the factors that must be achieved, as an absolute minimum, to ensure the successful implementation of EISs based on Data Warehouses?

1.4.2 Sub problems

The research problem is broken up into the following five sub-problems:

1. To what extent are EIS and Data Warehouse implementations in South Africa successful and how is this success measured?
2. What are those minimum factors that must be achieved to ensure the successful implementation of EISs, regardless of the technical infrastructure they are based on?
3. What are the additional factors for success when EISs are based on Data Warehouses?
4. What are the minimum factors that must be achieved to ensure the successful implementation of Data Warehouses, regardless of what they are ultimately going to be used for?
5. What are the additional factors for success of Data Warehouses when their purpose is to satisfy the information needs of senior executives?

1.4.3 Assumptions

The following assumptions have been made:

1. The term 'implementation' used in the research question includes all phases in the lifecycle of a Data Warehouse project, not just design, development, and installation.
2. The *perceived* success of a Data Warehouse implementation is adequate to describe whether it is in fact successful, and additional measures of success are therefore not necessary. For example, if an implementation is perceived to be a failure, even if there have been benefits, the implementation is effectively still a failure.

1.5 Aim and Objectives of the Research

This research is aimed at identifying, from a practical business perspective, those critical factors that contribute to the successful implementation of EISs based on Data Warehouses. These factors can serve as indicators of potential risks, as variables for consideration during planning and management, as a basis for judging the suitability of EISs based on Data Warehouses in particular situations, and as a basis for justifying an investment in Data Warehousing. Furthermore, these factors may provide an increased understanding of the reasons for the high failure rate of EISs and Data Warehouses and may reveal the measures that can be taken to improve the likelihood of success.

1.6 Importance of the Research

The high failure rate of EISs and Data Warehouses points to the need for a better understanding of what is required for success. This need increases as the interest and investment in these types of systems increases. Although there is a growing body of knowledge on EISs and Data Warehouses as subject areas on their own, this body of knowledge is not comprehensive. Furthermore, little work has been done to understand the factor success when Data Warehouses are specifically used for executive information rposes.

This research brings together and tests the factors reported as critical in the literature and puts forward practical guidelines for consideration when implementing EISs based on Data Warehouses, and in so doing will increase the current understanding.

1.7 Summary

The potential of EISs and Data Warehouses to meet the information needs of senior executives has generated considerable interest. However, the high risk, high cost, and high failure rate of both EISs and Data Warehouses indicates a lack of understanding of those factors that are critical to their success. This research is aimed at improving this understanding and at making a significant contribution to the growing body of knowledge.

A literature review was conducted to establish what are regarded as the CSFs for implementing EISs, Data Warehouses, and EISs based on Data Warehouses. The results of this review are discussed in chapter two.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

A comprehensive literature review has several important purposes (Leedy, 1997):

- It can reveal investigations focused on research problems similar to the one under consideration;
- It can reveal new sources of data;
- It can introduce the important research personalities in the field of research under consideration;
- It can show the current research in context from a historical and associational perspective;
- It can reveal new ideas and approaches; and
- It can serve as a comparison of similar research efforts.

In this chapter the results of a comprehensive literature review of the critical issues surrounding the implementation of Executive Information Systems (EISs) and Data Warehouses are examined. The objectives of the literature review are to gain an understanding of the following:

- What practitioners and researchers report to be the Critical Success Factors (CSFs) for implementing an EIS. This part of the literature review concentrates on those factors that must be achieved regardless of the specific technical infrastructure deployed to implement or support the EIS.
- What practitioners and researchers report to be the CSFs for implementing a Data Warehouse. This part of the literature review concentrates on those factors that must be achieved regardless of the ultimate purpose of the Data Warehouse, i.e. whether it is ultimately going to be used for reporting purposes, data mining purposes, decision support purposes, executive information purposes, or all of these.
- What practitioners and researchers report to be the CSFs that result from the unique marriage of EISs and Data Warehousing. These are the CSFs that would not exist if an EIS were not based on a Data Warehouse, or if a Data Warehouse were not used as the basis for an EIS.

The results of the literature review are presented in two major sections. The first covers the CSFs for implementing EISs and the second covers the CSFs for implementing Data Warehouses. These are then synthesised to develop the theoretical conjecture and associated empirical generalisations for this research. The results of the literature review also form the basis of the interview guide developed for collecting the primary research data. The interview guide is included as Appendix A.

2.2 The Critical Success Factors for Implementing Executive Information Systems

2.2.1 There must be a clear link between the information provided by an Executive Information System and the objectives of the business

Many executives have difficulty with Information Technology (IT) because they have no convincing picture of how IT relates to their business and information needs (Matthews and Shoebridge, 1992). According to Kelly (1994):

> "...one of the major difficulties with EIS implementations is that the information contained in the EIS fails to guide the organisation to its objectives."

A clear link, therefore, between the information provided by an EIS and the objectives of the business is critical to the success of an EIS (Watson and Frolick, 1993). An EIS should provide senior executives with the ability to track those key indicators they use to monitor the achievement of their strategic business goals (Watson and Frolick, 1992). Young and Watson (1995) and Walstrom and Wilson (1997) argue that if an EIS is not focused on a serious business purpose, it should not be developed.

To ensure that an EIS meets the stated business objectives, members of the project team should have an understanding of business issues and should be able to discuss these with executives (Matthews and Shoebridge, 1992).

2.2.2 The correct approach must be used to establish the system objectives and information requirements

One of the most important tasks of an executive is making decisions and one of the key resources available to them to allow them do this is information. Unfortunately, although executives spend most of their time trying to obtain the information they need, they tend to be overloaded with irrelevant, out of date and generally useless information (Wetherbe, 1991). As far back as 1967 Ackoff observed that managers appear to suffer more from an over abundance of irrelevant information rather than a lack of relevant information (Ackoff, 1967). Therefore, to be successful an EIS must provide the information needed by the senior executives it is designed to serve (Watson *et al.*, 1991).

A common problem associated with EISs is correctly determining the system's objectives and information requirements to allow the right system to be designed (Wetherbe, 1991; Watson and Frolick, 1993; Fitzgerald and Murphy, 1994; Walstrom and Wilson, 1997). However, the correct identification of these is critical to the success of an EIS (Houdeshel and Watson, 1987; Watson *et al.*, 1991). Ignorance of these, particularly the information requirements, can directly cause the failure of an EIS (Young and Watson, 1995).

A complicating factor is that managers often don't know what information they need (Wetherbe, 1991; Walstrom and Wilson, 1997) and if they do know what they need

they find it difficult to articulate this need (Watson and Frolick, 1993). As Watson and Frolick (1993) put it:

> "Simply asking the executive what information is wanted is unlikely to result in a comprehensive description of information needs."

It is also difficult for executives to easily define their system requirements because they are often not aware of the technology options available to assist them. Furthermore, it is often not possible or appropriate to formally train executives on the details of technological capabilities. According to Watson and Frolick (1993), instead of relying on executives to identify what can be done for them, a better approach is to gain a better understanding of their work.

Unfortunately, system developers often don't understand the nature of executive work (Watson and Frolick, 1993; Fitzgerald and Murphy, 1994). Executive work is usually diverse, brief, and fragmented and is more unstructured, non-routine, and long range in nature than other managerial work (Gorry and Scott Morton, 1989; Watson and Frolick, 1993; Nord and Nord, 1995). Mintzberg (1975) observes that the activities of senior managers are characterised by brevity, variety, and discontinuity, and are strongly action oriented. According to Nord and Nord (1995):

> "Executive decisions are generally broad and are based, to a large extent, on intuition."

Executives also prefer verbal communications because they like to exchange 'soft' information[1] (Mintzberg, 1972; Mintzberg, 1975; Watson and Frolick, 1993). As Mintzberg (1975) puts it:

> "...today's gossip may be tommorrow's fact."

Therefore, it is critically important to understand the decision making environment and personal style of the executives for which an EIS is being designed. According to Gorry and Scott Morton (1989):

> "...an understanding of managerial activity is a prerequisite for effective [management information] system design and implementation."

Mintzberg (1975) observes that the work of a manager is communication. He also observes that managers can be described as sophisticated information processing systems as they seem to spend about half their time moving information (Mintzberg, 1972). According to Rockart and Treacy (1982), 'classic' research shows executives not only to be verbally oriented, but that they have little use for 'hard' information. Furthermore, executives require external as well as internal information to be effective (Mintzberg, 1972; Mintzberg, 1975; Watson and Frolick, 1993). Mintzberg (1975) claims that two of the primary uses a manager has for information is to identify problems and opportunities, and to build mental models of things around him.

[1] **Soft information** is gossip, hearsay, speculation, ideas, opinions, predictions and explanations (Mintzberg, 1975; Watson and Frolick, 1993)

- ***Information Gathering Strategies***

Many strategies can be used for determining the system objectives and information requirements of senior executives but the most appropriate strategy depends on the users, the potential uses of the system, and the environment in which the system will be used (Watson and Frolick, 1992). The management style of the organisation will also play a significant role in the strategy used to determine these requirements. For example, it will be easier to link the information contained in an EIS to organisational objectives if the organisation is comfortable with establishing and working towards specific, measurable, achievable and consistent objectives. According to Watson and Frolick (1993) no single requirements gathering strategy is adequate and more than one should be used to triangulate on system and information requirements. This is because EISs evolve as executive information needs change in response to market and organisational changes (Watson and Frolick, 1993).

One requirements gathering strategy is to focus on the critical business issues or problems facing executives and the role that information plays in the solution of these problems (Wetherbe, 1991; Watson and Frolick, 1992; Watson and Frolick, 1993; Nord and Nord, 1995). This information is often used as the basis for developing decision support capabilities which are then included in EISs (Matthews and Shoebridge, 1992; Walstrom and Wilson, 1997). The lack of focus on a significant business problem is claimed to be a factor that often contributes to the failure of an EIS (Young and Watson, 1995).

A second strategy is to focus on the major decisions associated with an executive's area of responsibility, and the information that could result in better decisions (Ackoff, 1967; Wetherbe, 1991; Watson and Frolick, 1993).

A third strategy is to focus on the CSFs of the organisational unit/s of the executive under consideration, and the information needed to track the achievement of these (Houdeshel and Watson, 1987; Wetherbe, 1991; Watson and Frolick, 1992; Watson and Frolick, 1993; Nord and Nord, 1995; Walstrom and Wilson, 1997). This strategy requires considerable executive involvement and a skilled leader (Watson and Frolick, 1993). Furthermore, it should not be the only strategy used as executives require more than just CSF information (Watson and Frolick, 1993; Kelly, 1994). Kelly (1994) reports that some practitioners found the CSF approach to be useful during the initial development of an EIS but that after a while executives become almost as bored with the new information as they were with the old.

A fourth strategy is to focus on the organisation's strategic business objectives and the business processes required to accomplish these objectives (Watson and Frolick, 1993). Stein (1995) proposed the Information Success Factor (ISF) method which closely mirrors this strategy. His method starts with defining and prioritising ten business goals of the organisation. The top ranked goal is used to ascertain and prioritise business strategies. The top strategy is used to establish the personal tasks that the executive will perform to achieve the business goals. These tasks are related to the ISFs which are used as the basis of the EIS.

A fifth strategy focuses on determining the information needed to evaluate how effective goods or services provided by the organisation are to it's customers, and the

information needed to assess the efficiency with which these are produced/provided (Wetherbe, 1991).

- ***Information Gathering Techniques***

A variety of different techniques should be used to pursue the strategies discussed above. The suitability of a specific technique depends on the stage of development of the EIS. Furthermore, since it is unlikely that any one technique will be adequate it is important to apply the combination of techniques most suitable to an organisation. These techniques include (Watson *et al.*, 1991; Watson and Frolick, 1993):

- Discussions with executives;
- Examinations of computer generated information;
- Discussions with support personnel;
- Recording of volunteered information;
- Examination of other organisations' EISs;
- Examination of non-computer generated information;
- Participation in strategic planning sessions;
- Attendance at executive meetings;
- Examination of the organisation's strategic plan; and
- Tracking of executive activity.

In determining the information requirements, Wetherbe (1991) argues that the EIS should be viewed as cross-functional, requirements should be gathered in group forums such as Joint Application Design sessions, and indirect questioning techniques should be used.

Since so much of the information used by executives in their decision making process comes from a network of contacts outside the organisation it is important to consider how these information sources can be included in the EIS (Watson and Frolick, 1993).

2.2.3 A participative, iterative, prototyping approach must be used to implement an Executive Information System

According to Wetherbe (1991) a common mistake made in the development of EISs is that managers are not given the opportunity to refine their detail requirements through trial and error. If no provision is made for executives to communicate their ideas and insights the EIS is likely to fail (Young and Watson, 1995). In many cases Information Systems (IS) personnel do not adequately involve executives in the process of identifying their information requirements with the result that information is included in an EIS based on the extent to which it lends itself to capture, rather than on its value to executives (Fitzgerald and Murphy, 1994). Alavi (1982) observes that:

> "...it is only through the active and meaningful participation of the executive users in the design process that the designers can develop an understanding and appreciation for the executives' decision environments and requirements."

Since an EIS should be developed in response to a legitimate business need, the time taken to develop it is important (Watson *et al.*, 1991). Kelly (1994) claims that fast, cheap, incremental approaches to developing an EIS increase the chance of success. According to Young and Watson (1995) and Watson *et al.* (1996) an EIS must be developed and rolled out quickly while the need and executive interest is high. Matthews and Shoebridge (1992) also highlight the importance of quick results and argue that EIS implementations should show definite results within six weeks. Nord and Nord (1995) quote Snyder as saying that a key to the success of an EIS is that an initial version should be implemented and working within three to six months. In their 1988 study of large organisations in the USA and Canada, Watson and Kelly Rainer (1991) found that about eighty percent of initial versions of Executive Support Systems were complete within six months. In most instances this means that the development methodology for an EIS will differ from the rigid approach needed for Transaction Processing Systems (TPSs) (Watson and Kelly Rainer, 1991).

An ideal mechanism for allowing these objectives to be met is prototyping (Watson and Kelly Rainer, 1991; Watson *et al.*, 1991; Wetherbe, 1991; Young and Watson, 1995). Prototyping requires a high degree of user participation and in so doing improves the users' ability to clarify their requirements in an evolutionary fashion (Guimaraes and Saraph, 1991; Watson and Kelly Rainer, 1991). Prototyping is likely to be more useful to develop Decision Support Systems based on semi-structured or unstructured business problems, and is an effective vehicle to address poorly defined system requirements (Alavi, 1982; Guimaraes and Saraph, 1991). Wetherbe (1991) argues that prototyping is effective provided managers can interact with a prototype within days of discussing their requirements. Prototyping can help maintain executive interest and confidence in the project and help clarify screen presentation contents and formats (Watson and Kelly Rainer, 1991). Prototyping is therefore also a good mechanism for improving the useability of an EIS (Kelly, 1994). Guimaraes and Saraph (1991) claim the following additional benefits of prototyping:

- Reduction of lead times for requested information;
- Improved quality of reports;
- Development of systems that can easily be changed;
- Better definition of information requirements;
- Better problem specification;
- More timely systems development; and
- Better user/developer communication.

2.2.4 There must be active, demonstrated executive support and commitment

For the success of EIS projects, executive sponsorship is consistently found to be important (Houdeshel and Watson, 1987; Watson *et al.*, 1991; Watson and Kelly Rainer, 1991; Nord and Nord, 1995). Watson and Frolick (1993) and Young and Watson (1995) observe that lack of executive support and commitment is a major reason for EIS failure. According to Kelly (1994) this support should come from:

> "...a strong and vocal executive champion who consistently reinforces the purpose of the system and directs the attention of the executive group away from unproductive and punitive behaviours."

Watson *et al.* (1991) and Watson and Kelly Rainer (1991) claim that the most critical role with regards to executive commitment is that of the executive sponsor. This role involves making the initial request for the system, keeping abreast of its development, providing feedback and direction during development, and communicating strong and continuing interest to stakeholders.

Executive commitment is not only important to ensure that an EIS has the required support, but also to ensure that the objectives, priorities and needs of the executives for whom the systems is being developed, are reflected in it (Matthews and Shoebridge, 1992). According to Fitzgerald and Murphy (1994) a paradox for EIS success has emerged in that:

> "...executives will not use EISs until they (EISs) become an essential part of the executive management process, but this will not happen unless executives commit adequate time to the process of developing EISs."

For executives to be committed to an EIS they should have clarity regarding its purpose (Young and Watson, 1995). According to Kelly (1994) implementation of an effective EIS requires clear consensus on the objectives of the system. This clarity is also important to ensure that project responsibilities are clear (Overton *et al.*, 1996).

In most cases commitment will involve the personal *involvement* of the executive in the development of an EIS (Rockart and Treacy, 1982; Matthews and Shoebridge, 1992; Kelly, 1994). Watson and Kelly Rainer (1991) claim that the realisation of the benefits of an EIS requires more executive involvement than any other kind of computer system. Executives must spend time with developers to discuss their information requirements and to provide feedback on the information provided by the EIS and the format in which it is presented (Watson and Kelly Rainer, 1991; Watson and Frolick, 1993; Kelly, 1994). Executives must be actively involved in the design of the user interface to ensure that the system is easy to use, and to provide input on the importance of screen content and design (Watson and Satzinger, 1994).

It is highly likely that the development of an EIS without executive participation will result in failure of the system (Watson and Kelly Rainer, 1991; Watson and Frolick, 1993). However, since executive time is so scarce it is important to ensure that it is used effectively (Watson *et al.*, 1991; Watson and Frolick, 1993). The level of personal involvement will also depend on the management style of the organisation and personality of the senior executive involved (Matthews and Shoebridge, 1992).

The credibility of the developers and support staff in the eyes of the executives plays an important part in how committed the executives are likely to be to an EIS project. In a multi-stage study of the issues associated with identifying the information requirements for EISs, Watson and Frolick (1993) found that the amount of time an analyst gets is often related to how well the analyst knows the business. Inadequate business knowledge amongst EIS development and support staff can directly contribute to the failure of an EIS (Watson *et al.*, 1991; Young and Watson, 1995). Watson and Kelly Rainer (1991) argue that designers and support staff of systems for executives must be knowledgeable about business and management as well as information technology. Interpersonal and business skills are considered to be more important than technical skills. Watson *et al.* (1991) found that the ability to work

with executives is the most necessary skill for an EIS development team member, followed by knowledge of the business and interpersonal skills. According to Fitzgerald and Murphy (1994) while IS personnel may recognise the need for a more business-focused approach, this does not resolve the deficiency in business focused skills that currently exists.

Executive commitment is also required to ensure that the necessary data from the executive domain is made available to the EIS (Watson and Kelly Rainer, 1991).

2.2.5 The expectations of the end users must be managed

During the development of an EIS is it easy to fall into the trap of creating unrealistic expectations with regards to the type and usefulness of the information that will be provided by the EIS, the ease of use of the system, and the extent of the decision support capabilities that will be available. It is important to ensure that senior managers' expectations regarding the practical limitations of an EIS are managed, especially when there is no data available from any source to support the stated needs (Kelly, 1994). In cases where data is not readily available, collection mechanisms will have to be constructed (Kelly, 1994).

2.2.6 The politics must be managed

According to Glazer (1993) organisations that manage their information as a critical resource are truly information intensive. The mechanisms through which an organisation becomes information intensive is by measuring its information use, information share, information infrastructure, information operations, and information economies (Glazer, 1993; Earl, 1996). One of the primary difficulties of becoming an information intensive organisation is the management of information politics (Davenport *et al.*, 1992; Davenport, 1994). For example, most of the information needed to improve decision making within a particular functional area comes from outside that functional area (Wetherbe, 1991). However, users are often unwilling to participate in a system that will share information because information represents power, and most people are not interested in sharing power (Wetherbe, 1991; Kelly, 1994). Therefore, as knowledge and information replace capital as the primary source of wealth creation, who owns this knowledge and information or who has access to it will become increasingly political (Davenport *et al.*, 1992; Strassmann, 1996). Only when information politics are viewed as a natural aspect of organisational life and are consciously managed will true information intensive organisations emerge (Davenport *et al.*, 1992). Kelly (1994) claims that a key to the success of an EIS is an organisation that is comfortable with sharing information.

According to Overton *et al.* (1996) powerful members of an organisation often feel threatened by the implementation of an EIS because of the impact that such a system has on the upward flow of information in the organisation. Watson *et al.* (1991) claim that resistance to EISs comes from two major areas: organisational staff who are threatened by the possibility of a diminishing role; and subordinate managers who feel that their activities may be too transparent to senior executives.

Political resistance is a significant barrier that must be overcome as it often contributes to the failure of an EIS (Young and Watson, 1995). Overton *et al.* (1996) claim that organisational politics is considered to be the biggest problem encountered in an EIS project, and observe that political responses manifest themselves in a number of significant ways. These include initiatives to divert project resources, deflect project goals, dissipate project energies, and disconcert project administration.

To overcome political resistance, top management must use its influence and leadership to allow cross functional design to be achieved (Wetherbe, 1991). Overton *et al.* (1996) suggest that the active involvement of a powerful, influential executive sponsor is key to overcoming organisational politics, by demonstrating commitment, empowering EIS development staff, providing clear project specifications, and maintaining political awareness. They also suggest that EIS developers have a role to play by:

> "...securing the cooperation of key individuals, negotiating effectively, and recognising politics."

2.2.7 Information and data security issues must be addressed

To ensure transparency, EIS information should be available to everyone in the organisation (Kelly, 1994). According to Kelly (1994):

> "...information that must remain confidential should not be part of the EIS or the management system of the organisation."

This is because the performance of staff should not be managed using information that is not available to the staff themselves as this can result in, or encourage defensive, unproductive and generally destructive behaviour (Kelly, 1994).

Although EIS information should be available to all affected stakeholders within the organisation it can still be company confidential. For example, it may not be desireable to disclose this information outside the organisation to suppliers, customers and competitors.

2.2.8 There must be demonstrated value and benefit to the business

According to Overton *et al.* (1996) seventy percent of all EISs fail to provide significant value in excess of their costs. While this may seem to indicate a significant problem it is often not easy or appropriate to use traditional cost/benefit analyses on an EIS because of the difficulty in quantifying its benefits (Houdeshel and Watson, 1987; Watson *et al.*, 1991; Nord and Nord, 1995). Watson and Kelly Rainer (1991) claim that systems that support decision making are difficult to justify using standard economic evaluation methods, and that while costs can be estimated, a value cannot be assigned to the benefits. Rockart and Treacy (1982) support this view and assert that:

> "EISs provide no clear, easily defined cost savings. In fact, we know of no system that a traditional cost-benefit study would justify in straight labour saving terms."

Senior executives are oft prepared to invest in an EIS based on an intuitive feeling that the system will justif ts cost (Watson *et al.*, 1991) According to Walstrom and Wilson (1997):

> "CEOs may be willing to accept and support the development of an EIS for reasons other than direct impact on the bottom line."

In their study of EIS usage in *Fortune 500* companies, Nord and Nord (1995) found that eighty eight percent of the Chief Executive Officers (CEOs) believed that the usage of their EIS improved communication; sixty three percent of the CEOs indicated increased confidence in their decision making and greater access to previously unavailable information; and only twenty percent of the CEOs attributed increased profits directly to their EIS. In their case study of the Management Information and Decision Support System (MIDS) at Lockheed-Georgia, Houdeshel and Watson (1987) found that the benefits of the system include better information, improved communications, an evolving understanding of information requirements, a test bed for system evolution, and cost reductions. In the case of MIDS the cost reductions were associated with the reduced load on personnel to produce and distribute the various reports replaced by MIDS.

The true value of an EIS lies in the quality of the information it provides to executives. Therefore, the information content of the EIS is critically important to its success (Watson *et al.*, 1991; Fitzgerald and Murphy, 1994). If the information provided by an EIS does not have any context or relevancy in the decision making environment of the executive, there will be no incentive for the executive to use the system. Just as it is important to correctly establish the information requirements of executives it is important to ensure that the right information is presented back to executives, at the right time and in the right format (Fitzgerald and Murphy, 1994). Nord and Nord (1995) claim that according to Snyder a CSF for an EIS is that it should:

> "...contain exactly the information that its users most want and need to see."

2.2.9 The Executive Information System must provide good quality external and internal information

For success, the quality, relevancy and availability of information provided to executives by EISs are consistently found to be important (Rees Evans, 1989; Watson *et al*, 1991; Watson and Frolick, 1992; Nord and Nord, 1995; Young and Watson, 1995). One of the reasons why executives are concerned about adopting and using EISs is the potential for poor quality information in the system (Alavi, 1982). According to Rees-Evans (1989) the quality of information provided by an EIS is paramount to gaining and maintaining the end user's confidence and:

> "As soon as an executive starts to believe that the information he or she is seeing is wrong, the EIS is effectively dead."

To this end it is argued that a good MIS infrastructure is important to the success of an EIS, as it makes data collection for an EIS possible (Millet and Mawhinney, 1992) Although a great deal of information is available from an organisation's TPSs and MISs, it is often not available to executives in a meaningful, focused, and customised fashion, and these systems seldom contain external data (Walstrom and Wilson, 1997). According to Kelly (1994):

> "...integrating data from a wide range of data sources both inside and outside the organisation is one of the most critical issues for EIS users."

One of the attractions of EISs is that it focuses on transforming large amounts of data into controlled and understandable information *relevant* to decision making. EISs are therefore designed to overcome the 'data overload' problem that threatens the ability of executives to function (Matthews and Shoebridge, 1992).

Many of the decisions taken by senior executives focus on the external competitive environment of the organisation. A significant proportion of the information required by executives therefore comes from outside the organisation. To ensure that the information in an EIS is of value to the executives served by the system, it is critically important to provide access to relevant external information (Gorry and Scott Morton 1989; Watson *et al.*, 1991; Millet and Mawhinney, 1992). According to Drucker (1995):

> "...the need for information on the environment where the major threats and opportunities are likely to arise will become increasingly urgent."

In their 1988 study of large organisations in the USA and Canada, Watson and Kelly Rainer (1991) found that sixty five percent of Executive Support Systems in these organisations had access to external news services and fifty seven percent had access to other external databases.

A critical component of the quality of information is the speed at which it can be accessed (Houdeshel and Watson, 1987; Watson *et al.*, 1991). The speed at which information is retrieved is important to ensure that the context of the business question being asked is not lost by the executive having to wait for the system to respond. If the response time is too long the learning cycle will be interrupted and will stop, as will the usage of the EIS by the executive (Kelly, 1994).

To minimise the risk that executives base their decisions on information that is no longer relevant, it is important to ensure that the information provided by the EIS is up-to-date. Rees-Evans (1989) and Watson *et al.* (1991) claim that currency of information is one of the critical issues that an EIS must face. Mintzberg (1972) and Gorry and Scott Morton (1989) claim that the value of information in the context of strategic decision making often resides in its currency rather than its accuracy.

Haley and Watson (1996) claim that successful EISs often include soft information. Predictions, opinions, news, ideas, and even rumours influence the actions of

executives and often much of their decision making is based on this type of soft information (Watson *et al.*, 1996). It is therefore important that at least certain types of soft information are included in an EIS (Mintzberg, 1972; Watson *et al.*, 1991; Watson *et al.*, 1996). Based on a study of thirty two EIS developers Watson *et al.* (1996) determined that of all the various types of soft information, rumours, gossip, and hearsy are least likely to be included in an EIS while predications, forecasts and estimates are the most likely.

2.2.10 Adequate education and training must be provided

Although it is often not appropriate to formally train executive users, particularly with regards to technology issues, it is important to emphasise the merits of how EISs can assist the executive decision making process (Walstrom and Wilson, 1997). According to Walstrom and Wilson (1997) educating executives on basic EIS functionality and long term capabilities will help ensure the success of proposed EISs. If training is needed it should be done on a one-on-one basis (Watson *et al.*, 1991).

Rockart and Treacy (1982) observe that EISs often require a high level of personal support to executive users. This support comes from the EIS support staff but seldom involves formal training. It normally involves a continuous process of helping or coaching executive users to use an EIS.

2.2.11 The Executive Information System must be flexible

Since the critical issues facing the business change rapidly, the continued usage of an EIS depends on how flexible and adaptable it is to accommodate these changes (Rees-Evans, 1989; Millet and Mawhinney, 1992). Not keeping up with the changes in users' information requirements is a factor that contributes to the failure of EISs (Young and Watson, 1995). Kelly (1994) argues that:

> "...EISs must continually be updated to address the strategic issues of the day."

Kelly (1994) further argues that systems that are technical masterpieces tend to be inflexible and discourage innovation and experimentation, and that the time required to create them may mean that they are out of date before they are implemented.

The underlying architecture of an EIS should also be sufficiently flexible to allow the system to be tailored to the specific needs of more than one executive user (Walstrom and Wilson, 1997).

2.2.12 The Executive Information System must be easy to use

The user interface of an EIS is what the executive sees and interacts with. As Houdeshel and Watson (1987) put it:

> "An executive typically has little interest in the hardware or software used in a system. Rather, the dialog between the executive and the system is what matters."

Therefore, to ensure the success of an EIS it is critical that this interface is easy to use (Houdeshel and Watson, 1987; Watson *et al.*, 1991; Watson and Frolick, 1993; Watson and Satzinger, 1994; Nord and Nord, 1995; Young and Watson, 1995). Watson *et al.* (1991) claim that:

> "...the EIS must be so easy to use that it might be considered to be 'intuitive' or 'user seductive'."

To this end good graphical capabilities are important for presentation purposes (Watson and Kelly Rainer, 1991; Walstrom and Wilson, 1997). Watson and Kelly Rainer (1991), Young and Watson (1995), and Watson and Satzinger (1994) have found that not only graphical but tabular and textual information should be provided by EISs to make the information displayed more useful. Textual information adds insight and interpretation to data, and colour can also be useful to highlight exceptions and variances (Watson and Kelly Rainer, 1991). As much information as possible should be combined to appear on a single screen. Houdeshel and Watson (1987) claim that:

> "...executives prefer as much information as possible on a single display, even if it appears 'busy', rather than having the same information spread over several displays."

Millet and Mawhinney (1992) have found that EIS usage is generally limited to pre-specified options for data retrieval, status and exception reporting, and graphical presentations.

Ease of use not only refers to how the output is given to the user but also how the user directs the operation of the system, and the system must be designed to make both as easy as possible (Watson and Satzinger, 1994). If advanced analysis functionality were to be included in an EIS, it is unlikely that this would be used because executives usually do not have the skills, time or inclination to perform in-depth data analysis (Millet and Mawhinney, 1992). Due to the considerable time pressure senior executives are under it is unlikely that they will use a system that requires extensive training and regular use to be learnt and remembered (Watson *et al.*, 1991). According to Young and Watson (1995) complicated interfaces or extensive menus are frequently a factor contributing to EIS failure, and difficult to use technology generally results in user resistance. Watson and Satzinger (1994) claim that an executive should be able to use an EIS without training, and that systems that require more than fifteen minutes of instruction are unlikely to be used. Nord and Nord (1995) quote Snyder as saying that an executive should be able to use an EIS within approximately thirty minutes or less of instruction. Kelly (1994) argues that since managers have little time, a low tolerance for errors, and may initially have little incentive to use an EIS, they should be able to access its benefits without having to waste time learning how to use it. Furthermore, an EIS should be sufficiently intuitive to make instruction manuals unnecessary (Watson *et al.*, 1991; Watson and Satzinger, 1994).

Watson and Satzinger (1994) provide the following guidelines for designing a successful EIS user interface:

- Involve executives in the design of the interface;
- Set standards for screen layout, format and colour;
- Ensure that the use of the system is intuitive;
- Ensure that all terms used are defined;
- Design the main menu as a gateway to all computer use;
- Design the system for ease of navigation;
- Make the response time as fast as possible; and
- Expect preferences in user interfaces to change.

Furthermore, Watson *et al.* (1991) claim that an EIS should provide:

- Context dependent on-line help; and
- Menus and keyword index for locating screens and helping executives find information.

2.3 The Critical Success Factors for Implementing Data Warehouses

2.3.1 The data in a Data Warehouse must be relevant to the goals and performance measures of the business

Although a Data Warehouse has a variety of applications, in the context of supporting strategic business decisions its success and value depends on whether the data it contains is relevant to business goals and performance measures (Horrocks, 1995; Lambert, 1995b; Chang and Fergusen, 1996). Without understanding the business requirements, the Data Warehouse is not going to pay off (Fisher, 1996).

Technical architecture is only a small component of successful Data Warehouse implementations (Chang and Fergusen, 1996). According to Chang and Fergusen (1996) the most serious danger with an IT led Data Warehousing initiative is that the architecture is not likely to meet corporate objectives because the information is not mapped to the measurement, action and plannir processes of the organisation.

2.3.2 The correct approach must be used to understand the business requirements

In Data Warehousing, as in the development of any computerised information system, it is critical to properly identify the correct business requirements. Some researchers claim that understanding and analysing what the users actually require is the biggest obstacle to the success of a Data Warehouse (Chang and Fergusen, 1996). According to Demarest (1997) one of the problems that causes the high failure rate of Data Warehouses is that no consistent business-oriented design method is used, or no method is used at all. In the case of Data Warehousing the understanding of the business requirements can be one of the most difficult tasks because decision support requirements are indeterminate and unpredictable (Lambert, 1995b; Madsen, 1997). Orr (1997) claims that one of the reasons for this is that:

> "...Data Warehouse users typically don't know nearly as much about their wants and needs as operational users."

According to Lambert (1995b) this is because:

> "...different people want different information, information needs naturally change over time, and getting information generates the demand for more information."

There are a variety of approaches to establishing the business and information requirements for a Data Warehouse. Although there is general agreement that the approach used is critical to the success of a Data Warehouse project there is not the same level of agreement on what the best approach is. There appear to be three categories of approaches for establishing the requirements for a Data Warehouse.

The first approach is based on a top down strategic management approach. This involves identifying the information needed to track and support the goals, CSFs and performance measures of the business. Some researchers are finding that successful Data Warehouses are built on the information identified in this way (Welch, 1998; Horrocks, 1995; Lambert, 1995a; Lambert, 1995b; Chang and Fergusen, 1996). Defining requirements in this way puts them into context for the development team and highlights the value of the Data Warehouse to users (Lambert, 1995b). What is required, however, is an approach to the development of a Data Warehouse that differs fundamentally from the traditional Systems Development Life Cycle approach since the data requirements are fluid and unstructured and are meant to change in response to an ever increasing competitive landscape (Lambert, 1995b; Chang and Fergusen, 1996).

The second approach focuses on identifying and solving critical business problems (Kimball, 1996; Freeman, 1997). These problems should be relatively small and easily managed; have executive priority; be measurable with quantifiable benefits that exceed the cost of the solution; should be information based; should integrate data across systems; and should yield results in a short period of time (Kight, 1996, Kimball, 1996). Ideally the problems should be important enough that senior business managers participate in their solution. Furthermore, the required data should be available from source systems to allow the problems to be solved (Kimball, 1996). In his discussion of the Data Warehouse at Stanford University, Mundy (1995) observes that the greatest value of their Decision Support System is to illuminate business problems and point to their solutions. According to Madsen (1997) a Data Warehouse should be designed as a solution to specific problems within the business and should be focused on the right problem. Furthermore, the business must drive the selection of the problems to be solved (Madsen, 1997).

The final approach is the 'classical' view that Data Warehouses should be constructed in a bottom-up fashion, around an enterprise data model (Mundy, 1995; Welch, 1998). This approach addresses the supply side of Data Warehousing and allows for an understanding of what data is available to the organisation. However, by itself the approach is flawed as it does not consider the needs of the decision makers for whom the Data Warehouse is intended (Welch, 1998). In addition to lacking business

involvement, this approach is not likely to bear fruit as the data model will always change.

Implicit in the first two approaches is the need to simultaneously understand what data sources can reliably be used for the Data Warehouse (bottom-up view), both in terms of availability of data and support for the source systems (Kimball, 1996).

In much the same way as the approach to establishing the business requirements differs from the traditional Systems Development Lifecycle approach, the approach to data modelling differs from that for online TPSs. For example, the data in a Data Warehouse must be modelled to include the required level of detail and appropriate table structures. As Laberis (1997) puts it:

> "...Data Warehousing and online transaction processing are fundamentally very different approaches by IT to database technology"

2.3.3 A phased, iterative approach must be used to implement a Data Warehouse

Researchers and practitioners cite the importance of delivering a Data Warehouse in small, manageable, iterative phases rather than attempting to provide all the benefits at once (Radding, 1996; Foster, 1997; Freeman, 1997; Gomes, 1997; Scharl and Centric, 1997). Mundy (1995) advises that management should be impressed early and often to gain high visibility. According to Foster (1997) it is better to establish several phases that include short term, tangible deliverables based on subject areas rather than functional areas. In this way users can be provided with benefits they can see and touch in the short term (Foster, 1997; Gomes, 1997; Orr, 1997). Without this it is likely that the Data Warehouse initiative will lose support (Cafasso, 1996). However, the Data Warehouse should be extended by subject area, not functional area, within the framework of an overall architecture to ensure that the ultimate benefit of an enterprise-wide view of the data is still achieved (Kimball, 1996; Foster, 1997). According to Chang and Fergusen (1996):

> "...unless Data Warehousing solutions are implemented with a corporate-wide perspective, it is extremely difficult to identify business trends which are applicable to the business as a whole."

According to Fisher (1996) some experts disagree with the incremental approach. They argue that such an approach risks leaving out data that may produce unexpected results in the organisation.

2.3.4 There must be active, demonstrated executive and project team support and commitment

- *Executive support*

The success of a Data Warehouse depends on strong, active support from end users, business management and executives (Horrocks, 1995; Lambert, 1995b; Cafasso,

1996; Fisher, 1996; Chang and Fergusen, 1996; Kight, 1996; Foster, 1997; Madsen, 1997; Wellbrock, 1997). According to Cranford (1998):

> "Without strong commitment from management, the Data Warehouse is likely to fail."

Demonstrated support and commitment from senior executives should span the lifetime of the project, from inception to ongoing maintenance and support (Griffin, 1998).

Sponsorship of the Data Warehouse and making it a priority in the organisation is the responsibility of business leadership. Business leadership should include an executive sponsor who can convince business users that there is value in the Data Warehouse initiative, resolve business issues that arise during development, and give it the credibility needed for success (Cafasso, 1996; Madsen, 1997; Griffin, 1998). A senior executive who mandates the initiation of a Data Warehouse project is not necessarily a good sponsor (Madsen, 1997). An executive sponsor is typically a high level business executive who visibly supports, provides guidance, is actively involved, and shows faith in the project (Madsen, 1997; Griffin, 1998). According to Lambert (1995b) strong executive support will help overcome management resistance.

A critical aspect of obtaining executive support is ensuring that there is clarity of purpose for the Data Warehousing initiative. For business management and executives to have the required faith in the benefits of a Data Warehouse and to fully appreciate its value they must have clear, defined, explicit and achievable goals on what they want the Data Warehouse to achieve from a business perspective (Lambert, 1995b; Demarest, 1997; Freeman, 1997; Welbrock, 1997). To be successful the Data Warehouse team must focus on the objectives of the Data Warehouse (Kight, 1996). As Scharl and Centric (1997) put it:

> "Understand your problem before you try to define the system."

Clearly defined goals will provide the project team with focus and will provide a basis for the post implementation measurement of the success of the project (Kight, 1996). These goals are also an important aspect of keeping user's expectations in line (Cafasso, 1996).

At inception it is important for executives to provide managerial and financial support, and to become actively involved in defining requirements (Foster, 1997).

There must be commitment to ensuring that there is an adequate staffing structure in place to support the building, management, and maintenance of a Data Warehouse (Porter and Rome, 1994; Gomes, 1997; Griffin, 1998). To ensure that a Data Warehouse continues to add value there must be continued commitment to a support infrastructure, especially to retaining and developing good quality staff. According to Griffin (1998):

> "Commitment to long term staffing, which must meet or exceed the original commitment to actually building the Data Warehouse, is essential to success."

Senior management must also be committed to maintaining the quality of corporate data (Lambert, 1995a). A key activity in a Data Warehouse initiative is the sourcing, cleansing and loading of all the data elements required from the various operational systems into the Data Warehouse. For an enterprise-wide Data Warehouse, in particular, it is impossible for the Data Warehouse team to be responsible for this. Cooperation from the business to provide accurate, timely and current data for the Data Warehouse on an ongoing basis is critical to its success (Lambert, 1995a).

- ***Project team commitment***

A Data Warehouse project is not a part-time job (Porter and Rome, 1994; Gomes, 1997). Full time commitment from the project team is just as crucial to the success of a Data Warehouse as the commitment from users and sponsors, and can make or break the project (Griffin, 1998). In her case study of Mastercard's Data Warehousing initiative, Freeman (1997) reports:

> "It takes a commitment from a wide range of contributors, and if you don't have that, you are not going to be successful."

At face value Data Warehousing is attractive to IT staff who want to become involved in 'leading edge' technologies. Since Data Warehousing initiatives are often based on emerging technologies this is partially true. However, the majority of the work does not involve technology but focuses on extracting, cleansing and loading data into the Data Warehouse (Fisher, 1996). Even though tools do exist to automatically parse and analyse incoming data, break it into discrete elements, and to identify duplicate data, a considerable amount of manual work is still required (Radding, 1996). According to Laberis (1997) the Data Warehouse Institute estimates that seventy percent or more of the work involved in a warehouse is in the data transformation stage. Fisher (1996) puts this figure at sixty percent while Greenfield (1996) puts it as high as eighty percent. This work is usually tedious and boring but requires dedication and commitment from the project team because it is critical to ensuring that good quality data is fed into the Data Warehouse.

An important aspect of obtaining the required commitment from the project team is to clarify their roles and responsibilities. Because a Data Warehouse is not as structured as an operational system, it requires different approaches and skills to ensure success. These approaches and skills need to be oriented around providing data that has been optimised for decision support rather than transactional efficiency. Therefore, while the technological concepts may be well established they are different, and this often makes project team members uncomfortable (Fisher, 1996). According to Fisher (1996):

> "There's a lot of ambiguity in the roles of the information systems people when you start giving end users Data Warehouse tools."

- ***Project management***

Effective project management is the glue that holds everything together, including: managing cost and time deadlines, managing project team members, taking

responsibility for project deliverables, and facilitating communication and issue resolution. According to Griffin (1998):

> "...effective project leadership and management can make the warehouse project a success or doom it to failure."

According to Hackney (1997) the project team should be managed by a business person, not a technologist.

2.3.5 There must be effective communication

Effective and ongoing communication is critically important to the success of a Data Warehousing initiative (Foster, 1997; Gomes, 1997). This is to establish a feedback loop to the implementation team to ensure that user concerns and preferences are accommodated. It also ensures that users do not think that the project has slowed down (Foster, 1997). According to Kight (1996):

> "The more you communicate with your users, the more they will feel a part of the team, and the more understanding, patient, and proactive they will be in exploiting the technology. By keeping them in the communications loop, you make it easier to manage their expectations."

2.3.6 The political and cultural issues must be managed

Some authors argue that people and political issues outweigh technical issues as the cause of Data Warehouse failure (Demarest, 1997). It is felt that the management of political issues is potentially more difficult than the technology decisions that have to be made (Fisher, 1996). According to Cafasso (1996):

> "...the road to Data Warehousing is littered with as many people and political land mines as it is with technology obstacles."

Data Warehousing has an empowering effect by providing data to those who need it and in so doing affects the work practices of autonomous user communities in the organisation (Demarest, 1997). If this empowerment is seen as a threat then resistance will surface, especially from empire builders and information hoarders within the organisation (Cafasso, 1996).

According to Cafasso (1996) and Demarest (1997) Data Warehousing can create controversy and is potentially political because it spans functional areas and departments, which do not necessarily share the same goals. With Data Warehousing there is a need to change from a functional orientation to an analytical, subject based orientation to make it possible for users to become analytical and proactive. The necessary cultural shift requires a great deal of effort and is fairly painful to achieve (Fisher, 1996).

A potentially explosive issue in Data Warehousing is that of data ownership (Demarest, 1997). According to Cafasso (1996):

> "...it is critical to figure out who owns the data and who is responsible for the Data Warehouse before any steps are taken."

Often managers are reluctant to share their data for fear of losing their autonomy or perceived power. Furthermore, a Data Warehouse initiative often exposes poor data and information management practices as it begins to draw on the various data sources throughout the organisation (Demarest, 1997). To prevent this from becoming a politically sensitive issue the Data Warehouse team should openly acknowledge that they are expecting to find dirty, inconsistent and incomplete data (Demarest, 1997).

2.3.7 Information and data security issues must be correctly approached

One of the primary benefits of a Data Warehouse is that it can allow access to data previously not available, and it can allow this data to be viewed across the organisation. Therefore, in situations where there has historically been a 'need to know' philosophy to data access, it may be necessary to shift to a 'right to know' philosophy for the benefits to materialse (Greenfield, 1996). According to Porter and Rome (1994) security and privacy issues may stall or limit development of a Data Warehouse.

2.3.8 There must be demonstrated value and benefit to the business

Some researchers and practitioners claim significant Return On Investment (ROI) figures for Data Warehousing (Laberis, 1997; Cranford, 1998). Others report poor payback for the huge investments that have been made (Hackathorn, 1995). Fisher (1996) observes that it is interesting to note the wide range of returns reported, from gains of sixteen thousand percent to minus one thousand nine hundred percent. According to Cranford (1998), International Data Corporation (IDC) in Canada predicts a thirty eight percent annual compound rate of growth through the year 2000. A 1996 study by IDC of sixty two Data Warehouse implementations in organisations around the world showed an average three year ROI of four hundred and one percent (Fisher, 1996; International Data Corporation, 1996; Laberis, 1997). The IDC study found that over ninety percent of the organisations in the study reported ROI returns of over forty percent, half reported returns greater than one hundred and sixty percent, and one quarter showed returns greater than six hundred percent. The study also found that the average payback for a Data Warehouse is 2.3 years on costs averaging $US 2.2 million (International Data Corporation, 1996).

Demonstrated value is critical to the success of a Data Warehousing initiative (Laberis, 1997). This value can be both tangible and intangible, and cannot easily or always be measured or justified in traditional financial terms (Horrocks, 1995; Lambert, 1995b; Chang and Fergusen, 1996; Fisher, 1996; Cranford, 1998).

However, it is still important that there are clear, realistic expectations of the benefits of a Data Warehousing initiative (Horrocks, 1995; Lambert, 1995b; Chang and Fergusen, 1996; Fisher, 1996) and these should be defined at the outset (Cranford, 1998).

There appear to be three main schools of thought regarding demonstrated benefit from Data Warehousing. The first school argues that quantitative cost/benefit type measures should be avoided in justifying a Data Warehouse because ascertaining the tangible benefits from improved decision making is difficult (Porter and Rome, 1994). Examples of intangible benefits include a more efficient decision support infrastructure, better quality data, competitive advantage, and the ability to make faster decisions (Cranford, 1998).

The second school argues that quantitative benefits have to be proven to secure support and to demonstrate value in terms that the business will understand and appreciate (Demarest, 1997).

The third school argues that both tangible and intangible measures are important. For example, ROI evaluates tangible benefits against costs which is inadequate as the *only* measure of success of a Data Warehouse implementation. Therefore, additional measures should be sought to augment or even replace ROI, such as Net Present Value, Cost Displacement, Business Value-Add, and other measures that consider the intangible benefits (Cranford, 1998). Cranford (1998) argues that the tangible component of the measures are important because they provide statistical evidence of success as well as a mechanism for managing and retaining benefits.

2.3.9 The Data Warehouse must provide good quality data / information

The provision of good quality data[1] and good quality information[2] by the Data Warehouse is a CSF (Demarest, 1997; Laberis, 1997). In this context the term 'quality' encompasses availability, accuracy, timeliness, completeness, currency, and relevancy.

A significant aspect of providing good quality data is the consistent definition of each of the data elements in the Data Warehouse (Lambert, 1995a; Foster, 1997). For example, data elements with the same name may be defined differently (Lambert, 1995a). According to Laberis (1997):

> "...users can lose faith in the quality of data when there is no consistency in definitions across the enterprise..."

Hackathorn (1995) claims that:

> "...the essence of a Data Warehouse is that it provides a single image of business reality."

[1] **Data** is a series of observations, measurements, or facts (Hanks, 1991)
[2] **Information** is the meaning given to data by the way it is interpreted (Hanks, 1991)

Since decision support data should be drawn from the Data Warehouse, multiple definitions of data elements can undermine the ability of a Data Warehouse to be the 'single source of truth' throughout the organisation (Lambert, 1995a). Furthermore, the accuracy and validity of the data elements themselves must also be beyond question (Porter and Rome, 1994). It is also important to record the time at which the definitions for the various data elements were created to ensure that any changes in the decision support environment are reflected in the Data Warehouse (Lambert, 1995a).

The definition of each of the data elements used to populate the Data Warehouse should be encompassed in a data model (Radding, 1996). According to Radding (1996) the data model should be built up by the subject areas included in the Data Warehouse. An enterprise-wide data model is often inappropriate because of the effort involved in its development and because data is always being reorganised and redefined in a Data Warehouse (Radding, 1996).

In addition to consistent data definitions there is also a need to develop consistent business rules (Greenfield, 1996). These business rules will dictate how various mathematical manipulations will be performed on data elements in the Data Warehouse, and how the results will be presented. Inconsistent application of calculations will quickly lead to a proliferation of different interpretations of the information elements.

If the data provided by a Data Warehouse is not relevant to the business problems under consideration, or to the spheres of responsibility of the users, there is no reason or incentive for the users to look at the data or to use the Data Warehouse (Madsen, 1997).

Another aspect of good quality data is the level of detail provided for decision making (Lambert, 1995a). Typically executives require highly summarised data / information to support the types of decisions they make (Radding, 1996). Furthermore, absolute accuracy is seldom necessary (Mintzberg, 1972; Gorry and Scott Morton, 1989). In the context of Data Warehousing, however, it is often necessary to load the individual data elements that make up the summary figures into the Data Warehouse (Lambert, 1995a). This allows 'drill down' where necessary, to permit access to the detail behind the summary figures, and to establish the root cause of areas of concern (Radding, 1996; Lambert, 1995a). The provision of detail also allows summaries to be made in different ways depending on the business problem under consideration (Lambert, 1995a). It also removes ambiguity and interpretation from the way in which the summarised figures were obtained.

In a decision support environment it is also important to record the time for which data or information elements are applicable. This is because decision support tends to deal with trends rather than single points in time (Lambert, 1995a).

2.3.10 There must be active participation by end users

The participation of users is important to ensure that they appreciate the benefits of the Data Warehouse and take full ownership for the project (Demarest, 199[illegible]ight,

1996). Although it is possibly only feasible for executive users to be actively involved in defining their information requirements and to attend feedback and progress meetings, other users such as business analysts should become involved in data quality assurance and testing (Radding, 1996; Foster, 1997). If the Data Warehouse is used to solve significant business problems then end users should also be actively involved in the solution of these problems (Radding, 1996).

2.3.11 Adequate education, training and end user support must be provided

Business users should be empowered to collect and analyse their own data. However, they need to be coached, mentored and trained to use the front-end tools associated with Data Warehousing (Porter and Rome, 1994; Griffin, 1998). This training will give the user community the required confidence to effectively access and analyse the data in a Data Warehouse, and focus on gaining a better understanding of business issues. According to Griffin (1998):

> "A confident user community and properly trained warehousing team greatly enhance an organisation's Return On Investment."

According to Kight (1996), education of end users and making them aware of the technology and the benefits of their active participation is key to current and future success of a Data Warehouse initiative. However, even though end user training reduces the number of questions that may arise, there is still a need to provide a support infrastructure to deal with ongoing support needs and queries (Porter and Rome, 1994).

Data Warehousing encompasses a variety of technologies and approaches that differ significantly from those used in 'traditional' online TPSs. Therefore, it is necessary to invest not only in the training of end users but also training of technical staff such as designers, implementors, and database administrators (Demarest, 1997). The training of technical staff may be significant due to the new technologies and concepts involved, and due to the unstructured nature of the decision support environment (Mundy, 1995).

2.3.12 Good quality front-end tools must be provided with the Data Warehouse

The success of a Data Warehouse often depends on the quality of front-end tools (Demarest, 1997). Unfortunately, there is not a consistent definition of what a 'good quality' front-end tool is. Since these tools are the interface between the user and the Data Warehouse their ease of use, performance, flexibility to be tailored to individual needs, and functional richness can, and often does, dictate the usage and ultimate success of the Data Warehouse (Welbrock, 1997). Of these characteristics the most critical is ease of use (McElreath, 1995; Radding, 1996; Scharl and Centric, 1997; Welbrock, 1997). Performance is another characteristic that is regarded as very important (Horrocks, 1995; Lambert, 1995b; Chang and Fergusen, 1996). The performance of a front-end tool refers to the speed at which it can provide access to data and the results of analysis, to decision makers (Radding, 1996).

There are two schools of thought on front-end tools. The first, which is supported by most vendors, argues for an integrated toolset with a common look and feel. It is based on the assertion that the toolset should be flexible enough to span the spectrum of access features needed by users (Laberis, 1997).

The second school argues for a range of dedicated tools depending on the functionality requirements of users. In this case it is argued that dedicated tools are better for performing specialist functions and that an integrated toolset is too much of a compromise. There are, however, obvious cost, training, support, maintenance, and integration issues associated with deploying a variety of tools within an organisation

Logically, users should see a common interface for all the available functionality and this interface should encompass all the information and functionality needs of each user, particularly where these users are executives. From the perspective of the executive user there should be a common look and feel to minimise or avoid training, but the exact technology or tool supporting the interface should be transparent to him or her.

2.3.13 The Data Warehouse must be flexible

The flexibility of a Data Warehouse and its associated tools is important to easily and quickly accommodate advances in technology, changing user needs, changes in demand for access to data, changes in the business environment, or changes in the organisational environment (McElreath, 1995; Greenfield, 1996; Kight, 1996; Cranford, 1998). In the context of Data Warehousing the need for flexibility encompasses the technology architecture (openness, scalability), the data/information architecture, and the support infrastructure.

Technical flexibility is important in the context of scalability (Demarest, 1997; Foster, 1997; Laberis, 1997; Orr, 1997). It is claimed that a successful, well constructed Data Warehouse is one that sees a dramatic increase in users and usage (Lambert, 1995b; Laberis, 1997; Orr, 1997). According to Laberis (1997) a study by the Data Warehousing Institute of its user members found that demand typically doubles after three months, doubles again after another six months, and doubles again a year after that. For this reason it is advisable to overestimate for size, performance, capacity, and costs (Foster, 1997).

2.4 Theoretical Conjecture

It is now possible to postulate a theoretical conjecture based on the research problem at hand and the results of the literature review.

A theoretical conjecture provides a consistent story that describes the essential features of the problem under investigation (Remenyi and Williams, 1993b). It is a narrative articulation of a theory, where the theory is based on concepts found in the literature (Heafield, 1995). According to Heafield (1995):

"...there is no formal methodology for developing a theoretical conjecture and it is primarily a creative process."

Therefore, the following theoretical conjecture is posited for this research:

The CSFs for implementing an EIS based on a Data Warehouse are:

- A clear link between the data / information provided and the goals and performance measures of the business;
- The use of an appropriate approach for establishing the system objectives and business information requirements;
- The use of an iterative, prototyping approach for implementation;
- Active, demonstrated support and commitment from executives and the project team;
- Appropriate management of end user expectations;
- Appropriate management of political and cultural issues;
- The resolution of data and information security issues;
- Demonstrated value and benefit to the business;
- The provision of good quality external and internal information to end users;
- The active participation of end users;
- The provision of adequate education and training;
- Adequate flexibility to meet the specific needs of executive users, and to allow changes to be made in response to changes in the user base and their information requirements; and
- Ease of use.

2.5 Empirical Generalisations

The theoretical conjecture, in itself, is not sufficient to allow the theory encompassed in it to be operationalised or tested against a sample population. It needs to be further developed into a set of empirical generalisations which can be tested against primary data to examine the validity and usefulness of the theory (Steer, 1995; Heafield, 1995). The following empirical generalisations were developed from the theoretical conjecture:

- There must be a clear link between the data / information provided by an EIS based on a Data Warehouse and the goals and performance measures of the business;
- An approach, which is best suited to the specific circumstances of the business, should be used to establish the system objectives and business information requirements of an EIS based on a Data Warehouse;
- An iterative, prototyping approach must be used to implement an EIS based on a Data Warehouse;
- There must be active, demonstrated support and commitment from both executives and the project team when implementing an EIS based on a Data Warehouse;
- The expectations of the end users of an EIS based on a Data Warehouse must be managed;

- The political and cultural issues surrounding the implementation of an EIS based on a Data Warehouse must be managed;
- The issue of the security of data and information must be resolved when implementing an EIS based on a Data Warehouse;
- There must be demonstrated value and benefit to the business when implementing an EIS based on a Data Warehouse;
- An EIS based on a Data Warehouse must provide good quality external and internal information to end users;
- There must be active participation by end users when an EIS based on a Data Warehouse is implemented;
- End users must be provided with adequate education and training when implementing an EIS based on a Data Warehouse;
- The EIS and Data Warehouse must be flexible enough to be tailored to the specific needs of executive users, and to be changed in response to changes in the user base and their information requirements; and
- An EIS based on a Data Warehouse must be easy to use.

For the purposes of this research the level of support for the theoretical conjecture and empirical generalisations was based on the results of semi-structured interviews. The interview guide used was therefore based on the empirical generalisations, and is attached as Appendix A.

2.6 Summary

This chapter examined the literature to establish the CSFs for implementing EISs based on Data Warehouses. Most of the literature reviewed dealt either with EISs or Data Warehouses as subject areas on their own. The literature review was presented as a narrative description and was synthesised to develop the theoretical conjecture and empirical generalisations for this research. The empirical generalisations form the basis of the interview guide used to collect the primary research data. Chapter three presents the research methodology within which the research was conducted.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

In the previous chapter an extensive literature review of the issues surrounding the implementation of Executive Information Systems (EIS) based on Data Warehouses, was presented. The literature review was presented as a narrative description, which was used as the basis for developing the theoretical conjecture. The theoretical conjecture was then developed into empirical generalisations, which are testable against the research evidence that has been collected.

This chapter develops an argument for the research approach adopted, and presents the research methodology, or procedural framework, within which the research was conducted. This procedural framework is broken down into various processes or steps and the specific research methods used in each step, and how they were applied, are discussed in greater detail.

3.2 Research Approach and Methodology

The aim of research is to add to the body of established knowledge in the chosen subject area, by addressing some of the myriad unanswered questions (Remenyi and Williams, 1993a; Remenyi and Williams, 1993b).

Leedy (1997) defines research to be:

> "...the systematic process of collecting and analysing information (data) in order to increase our understanding of the phenomenon with which we are concerned or interested."

Leedy (1997) goes on to say that research is a *process* through which we attempt to achieve systematically, and with the support of data, the answer to a question, the resolution of a problem, or a greater understanding of a phenomenon. This process is broadly referred to as the research methodology. Remenyi and Williams (1993a) define a research methodology to be the procedural framework within which the research is conducted. According to Leedy (1997) the research methodology has two primary functions:

- To control and dictate the acquisition of data; and
- To correlate the data after acquisition and extract meaningfulness from them.

3.2.1 Linking data and research methodologies

Leedy (1997) argues that data and methodology are inextricably interdependent and for this reason the research methodology to be adopted for a particular problem must recognise the nature of the data that will be collected in the resolution of the problem.

Leedy (1997) cautions that the research methodology is merely an operational framework within which the data are placed so that their meaning may be seen more clearly and that depending on the types of questions to be answered, different research designs and methods will be more or less appropriate. The many methodologies in existence resolve into two major approaches for collecting and analysing data (Leedy, 1997):

- Quantitative approaches; and
- Qualitative approaches.

Some refer to the quantitative approaches as the *traditional*, the *positivist*, the *experimental*, or the *empiricist* approaches, and some refer to the qualitative approaches as the *interpretative*, the *naturalistic*, the *constructivist*, or the *postpositivist* approaches (Leedy, 1997).

It is within these two main approaches that a number of research methodologies are used to gather data appropriate for answering different research questions (Leedy, 1997). Remenyi and Williams (1993b) stress the importance, especially in information systems research, of deciding if the data one collects will be of an essentially qualitative or quantitative nature. This is because it is the data that dictates the research methodology (Leedy, 1997).

Creswell (1994) defines a quantitative study as:

> "...an inquiry into a social or human problem based on testing a theory composed of variables, measured with numbers and analysed with statistical procedures, in order to determine whether the predictive generalisations of the theory hold true."

Furthermore, Creswell (1994) defines a qualitative study as an:

> "...inquiry process of understanding a social or human problem based on building a complex, holistic picture, formed with words, reporting detailed views of informants, and conducted in a natural setting."

According to Leedy (1997) a quantitative study usually ends with confirmation or disconfirmation of the hypotheses that were tested. On the other hand a qualitative study may conclude with tentative answers or hypotheses about what was observed. Since the tentative hypotheses may form the basis of future quantitative studies designed to test the proposed hypotheses, qualitative and quantitative approaches represent complimentary components of the research process. Remenyi and Williams (1993b), who argue that qualitative and quantitative approaches are not mutually exclusive and that research

scientists will often work with both, support this view. Therefore, according to Remenyi and Williams (1993b) qualitative and quantitative research approaches are best viewed as the ends of a continuum.

Depending on the goals of the research different methods or techniques, within each methodology, will be used for sampling, data collection, and analysis, as well as different styles of writing and communicating results. According to Remenyi and Williams (1993a) one of the methodologies most frequently used in information systems research, when the researcher is unable to conduct an experiment and has to rely on evidence that already exists, is *passive observation*[1]. Using passive observation the researcher collects evidence in the form of interviews, written reports, questionnaires, artifacts, etc. (Remenyi and Williams, 1993a).

For this research it was not possible to conduct an experiment and it was necessary to interact with the respondents to understand and contextualise what they believed to be the categories of Critical Success Factors (CSFs) for implementing EIS based on Data Warehouses. Therefore, the essentially qualitative passive observation methodology illustrated in the flowchart in figure 3.1 was used.

3.3 Development of the Theoretical Conjecture

3.3.1 Literature review

Since the aim of research is to add to the body of knowledge in the chosen subject area it is necessary to have a comprehensive understanding of what the existing body of knowledge is. Therefore, a necessary first step in the research process is to review the published literature. The primary objectives of the literature review for this research were:

- To reveal and understand the established facts of the situation; and
- To establish the current theories or models which have been used by previous researchers in the field.

The literature review for this research focused on more recent literature on EIS and Data Warehousing as well as on 'classic' articles frequently referred to as important in the literature. It included a review of literature published in recognised academic and trade journals and on Internet web pages.

During the literature review it became apparent that little had been published specifically on the issues surrounding the unique marriage of EIS and Data Warehousing. There was, however, a wealth of published material on the issues surrounding the implementation of EIS. Similarly, there was also a wealth of published material on the issues surrounding

[1] **Passive observation** is used to describe activities ranging from pure observation during which the act of observation in no way affects the situation being observed, to observations based, for example, on questionnaires in which the act of asking and the relationship between observer and observed may influence the reply that is given (Remenyi and Williams, 1993a).

the implementation of Data Warehouses. Therefore the literature review was logically split into two phases. The first phase involved reviewing EIS oriented literature, to identify those issues regarded as critical to the implementation of EIS. The second phase involved reviewing Data Warehouse oriented literature, to identify the issues regarded as critical to the implementation of Data Warehouses. Where published material did refer to the issues associated with the marriage of EIS and Data Warehousing this information was also recorded. The essential features of both phases of the literature review are presented in an ordered context in chapter two, sections 2.2 and 2.3. In this context the relevance of these essential features is easily understood and they form a higher order narrative (Remenyi and Williams, 1993b). The theoretical conjecture presented in chapter two, section 2.4 is simply the formalisation of the conclusions of the higher order narrative.

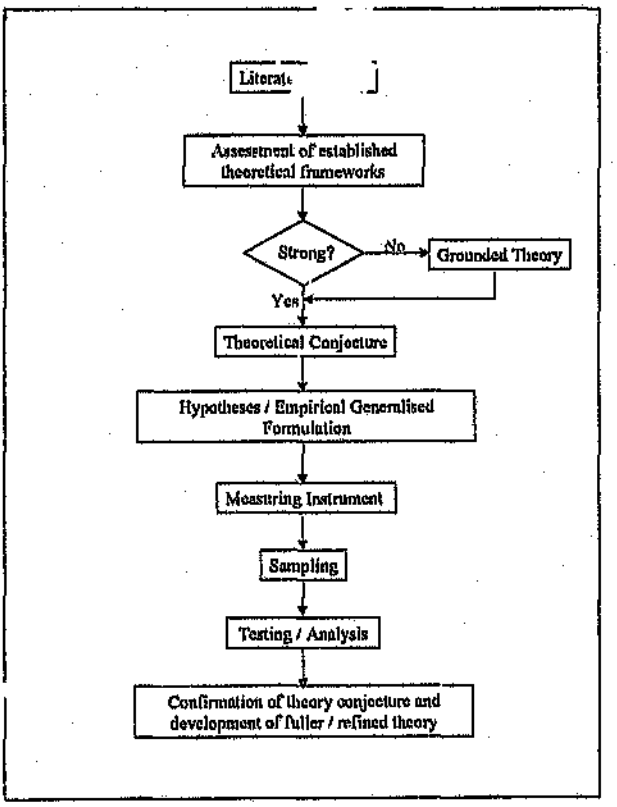


Figure 3.1 Steps in the Passive Observation Research Process (Remenyi and Williams, 1993a)

3.3.2 Assessment of established theoretical frameworks

It is possible to investigate a new aspect of a subject on which little has been published and to establish the point of departure for the research using empirical techniques such as grounded theory or concept discovery (Remenyi and Williams, 1993b). For this research, however, there was sufficient published material to generate the information required for a narrative description of the current understanding in the field of study, without having to explicitly use techniques such as grounded theory or concept discovery. However, in the process of developing the narrative, categories were developed from the data, which *implicitly* required invoking a process of concept discovery and recourse to an element of grounded theory. This narrative is presented in chapter two, sections 2.2 and 2.3.

3.3.3 Theoretical Conjecture

There is no structured methodology for making a theoretical conjecture. It can be regarded as an art which relies heavily on the imagination of the researcher (Remenyi and Williams, 1993a). For completeness the theoretical conjecture presented in chapter two, section 2.4 is repeated below.

The CSFs for implementing an EIS based on a Data Warehouse are:

- A clear link between the data / information provided and the goals and performance measures of the business;
- The use of an appropriate approach for establishing the system objectives and business information requirements;
- The use of an iterative, prototyping approach for implementation;
- Active, demonstrated support and commitment from executives and the project team;
- Appropriate management of end user expectations;
- Appropriate management of political and cultural issues;
- The resolution of data and information security issues;
- Demonstrated value and benefit to the business;
- The provision of good quality external and internal information to end users;
- The active participation of end users;
- The provision of adequate education and training;
- Adequate flexibility to meet the specific needs of executive users, and to allow changes to be made in response to changes in the user base and their information requirements; and
- Ease of use.

3.4 Empirical Generalisations

According to Remenyi and Williams (1993b):

> "A theoretical conjecture alone will not be enough to allow the theory to be operationalised in a practical and useful way. For this to happen paradigmatic thinking is needed which requires the theoretical conjecture to be developed into one or more hypotheses or empirical generalisations."

The objective of developing empirical generalisations is to produce a set of clear statements which are testable against further evidence (Remenyi and Williams, 1993a). The empirical generalisations developed from the theoretical conjecture, which were presented in chapter two, section 2.5 are repeated below.

- There must be a clear link between the data / information provided by an EIS based on a Data Warehouse and the goals and performance measures of the business;
- An approach, which is best suited to the specific circumstances of the business, should be used to establish the system objectives and business information requirements of an EIS based on a Data Warehouse;
- An iterative, prototyping approach must be used to implement an EIS based on a Data Warehouse;
- There must be active, demonstrated support and commitment from both executives and the project team when implementing an EIS based on a Data Warehouse;
- The expectations of the end users of an EIS based on a Data Warehouse must be managed;
- The political and cultural issues surrounding the implementation of an EIS based on a Data Warehouse must be managed;
- The issue of the security of data and information must be resolved when implementing an EIS based on a Data Warehouse;
- There must be demonstrated value and benefit to the business when implementing an EIS based on a Data Warehouse;
- An EIS based on a Data Warehouse must provide good quality external and internal information to end users;
- There must be active participation by end users when an EIS based on a Data Warehouse is implemented;
- End users must be provided with adequate education and training when implementing an EIS based on a Data Warehouse;
- The EIS and Data Warehouse must be flexible enough to be tailored to the specific needs of executive users, and to be changed in response to changes in the user base and their information requirements; and
- An EIS based on a Data Warehouse must be easy to use.

3.5 Data Sample Selection

A very important aspect of the research process is selecting a sample to ensure that it is both representative and unbiased (Remenyi and Williams, 1993a). To obtain an impartial representation of South African organisations, and to make valid generalisations, the sample size of respondents was as large as possible for the time available. Respondents included practitioners at senior management level, regardless of industry sector, who were directly involved in the provision of information to senior business executives using Data Warehouses.

The respondents for pilot interviews were selected from the list of speakers at the Data Warehouse and Knowledge Management '98 conference held in Sandton from 16 to 18 March 1998. These respondents were selected based on their practical experience in implementing Data Warehouse and executive information solutions, and their willingness to be interviewed, rather than based on a particular industry segment. At each interview, including the pilot interviews, the respondent was asked to nominate another suitable respondent. This approach is referred to as theoretical or snowball sampling and is an acceptable method of collecting evidence from a group of qualified respondents (Remenyi and Williams, 1993a). Where respondents were unable to nominate another suitable respondent additional respondents were nominated from the list of speakers at the conference.

Since Data Warehouse initiatives are expensive there are not many such implementations in South Africa. The snowball sampling soon resulted in the same respondents being recommended more than once. In the time available a total of eighteen interviews were conducted, including three pilot interviews. Although three more potential respondents were recommended, two of them were unwilling to be interviewed and one could not be contacted during the interview period.

3.6 Data Gathering Strategy

When a theoretical framework is well defined it is possible to start with a clear expectation of how a particular phenomenon is likely to behave. It is also likely that the theoretical framework has been formalised into a model or paradigm. It is usually obvious what data are required and they are usually collected within a tight structure. Furthermore, the hypotheses can usually be rigorously tested using appropriate statistical techniques. In such cases the use of quantitative data collection and analysis techniques will be required (Remenyi and Williams, 1993b).

For this research there is no well-defined theoretical framework. Furthermore, while it is possible to speculate what the CSFs for implementing EISs based on Data Warehouses are, it is not possible to predict their degree of generality. This research, therefore, requires the collection of complex qualitative evidence concerning issues such as 'why', 'how' and 'who' is critical to the success of EISs based on Data Warehouses. To this end a semi-structured interview technique was used for data collection, while content

(textual) and interpretive analyses were used to analyse the research data. According to Remenyi and Williams, 1993a:

> "Structured or semi-structured interviews allow detailed evidence to be elicited from individual informants who are encouraged to raise and suggest issues and problems which they regard as important to the issue being researched."

3.6.1 Refinement of the interview approach and interview guide

A draft interview guide was developed based on the literature review, and was presented to the research supervisor for review and comment. After the research supervisor's comments and suggestions were incorporated into the interview guide, three pilot interviews were conducted with a sample of EIS and Data Warehouse practitioners. The objectives of presenting the interview guide to the research supervisor, and of conducting the pilot interviews, were to establish whether:

- The proposed interview guide was intelligible, unambiguous and clear (is comprehensible);
- The proposed interview guide was reliable and valid (checks responses for consistency);
- The proposed interview guide covered only the relevant issues (is economical);
- The proposed interview guide was adequate to allow all the data relevant data to the research question to be gathered (is complete); and
- The proposed interviewing technique would be appropriate and valid to achieve the research objectives (is balanced).

The same interview approach that was proposed for the data gathering process was used during the pilot interviews. After each of the pilot interviews the respondents were asked to comment on the process used, including the interview technique, topics covered, interview guide, and duration of interview. In all cases there were very few, if any, criticisms of the approach used. Once this process was complete, and the necessary changes were made, the interview approach and interview guide were deemed ready for the data gathering process. The final interview guide used is attached as Appendix A.

3.6.2 Semi-structured interviews

To prevent introducing bias into the interview process the interview guide was not sent to any of the respondents before the interview or shown to them during the interview. At the start of the interview the respondent was reminded of the objective of the research, and the concept of CSFs was explained to them. The respondents were then asked a number of demographic questions after which they were asked to comment, in their own words, and based on their own experiences, on what they believed to be the CSFs for implementing EISs based on Data Warehouses. The following probing techniques were used to encourage respondents to raise and suggest issues they thought were important:

- Respondents were encouraged to be specific and to explain the issues they raised; and
- The answers or explanations provided by respondents were reflected back to them to ensure that there was a mutual understanding of the issues raised.

The interview guide was only referred to once the respondents were comfortable that they had covered what they thought were the CSFs. Furthermore, the respondents were only asked to comment on how important they thought the issues on the interview guide were that they themselves had not referred to during the interview.

Since the respondents were left to express their opinion on what they thought the CSFs were for implementing EISs based on Data Warehouses they sometimes raised issues not addressed in the interview guide.

Only one respondent objected to being tape recorded, and very detailed notes were taken during this interview. The rest of the interviews were all tape recorded, and additional notes were also taken during these interviews. The answers of the respondents who were tape recorded did not seem to have been affected in any way by the fact that they were being recorded.

The average length of each interview was 60 minutes, with some lasting only 45 minutes and others lasting as long as 120 minutes. All the interviews were transcribed verbatim into a 130 page document.

3.7 The Data Testing / Analysis Strategy

Since detailed research evidence was collected from a relatively small number of respondents, using a semi-structured interview technique, it is essentially qualitative in nature. The data collection process lacked the required precise measurement of the properties or performance of the subject to be regarded as essentially quantitative (Remenyi and Williams, 1993b). Appropriate techniques for analysing qualitative evidence are content or correspondence analysis (Remenyi and Williams, 1993a). Berelson (1952) defines content analysis to be:

> "...a research technique for the objective, systematic, and quantitative description of the manifest content of communication."

Content analysis involves establishing a set of categories and then counting the number of instances in a particular logical unit of analysis[2] that fall into each category (Silverman, 1993).

Silverman (1993) argues in favour of the quantitative nature of content analysis and describes it as the favoured method of quantitative researchers. Although Remenyi and Williams (1993b) also refer to content analysis as a quantitative data analysis technique,

[2] An example of a logical unit of analysis is an interview transcript

they claim it to be quintessentially qualitative in character. For the purposes of this research, however, content analysis was used in both quantitative and qualitative contexts.

The basic unit of analysis was a logical 'theme' or category derived from each of the empirical generalisations. A theme is an assertion about a subject matter and in its most compact form is a simple sentence (Berelson, 1952). For example, the first empirical generalisation states that there must be a clear link between the data / information provided by an EIS based on a Data Warehouse, and the goals and performance measures of the business. Each time a respondent mentioned the need to link data / information to the goals and performance measures of the business as being critical to success, this was counted and recorded as an instance of occurrence for that respondent. Once the interview transcript for a particular respondent had been analysed all the instances of occurrence of a particular theme were added up for that respondent. The number of times a respondent mentioned a particular theme is an indication of the relative importance that the respondent places on that occurrence. Once all of the interview transcripts of all of the respondents had been analysed the total instances of occurrence were summed to establish the relative importance of each different theme, aggregated over the population of respondents. This was done to establish a general view of the importance of each theme relative to other themes. Deductive reasoning was used to move from the existing premise of the empirical generalisations to a conclusion about the extent to which the research evidence supports the empirical generalisations. Therefore, in this context the method of data analysis is essentially quantitative in nature and concludes with a confirmation or disconfirmation of the empirical generalisations.

New themes, not derived from the empirical generalisations, that emerged through the analysis of the interview transcripts were also recorded for each respondent. These new themes were recorded together with their instances of occurrence and formed the basis of further developing the theory. These themes provided additional insights and inductive reasoning was then used to refine the theoretical conjecture. In so doing a more complete explanation of the phenomenon being studied is provided. In this context, and due to the interpretive nature of the analysis, the research took on a qualitative aspect.

3.8 Summary

This chapter presented the rationale for the research approach and supporting methodology that was adopted for this research. Furthermore, it presented the rationale for the specific techniques used in each step of the process outlined by the methodology chosen. Based on the data that needed to be collected to achieve the research goals, the passive observation methodology was used for this research. It is a process that consists of the following steps:

- An extensive literature review;
- An assessment of established theoretical frameworks;
- The development of theoretical conjecture;
- The development of empirical generalisations;

- The choosing of a measuring instrument and implementation of a data gathering strategy. Semi-structured interviews were used to collect the research evidence;
- The selection of a representative sample of respondents. This was done using the snowball sampling technique;
- The implementation of a strategy to test and analyse the research evidence collected. Quantitative and qualitative 'content analysis' was the primary technique used to analyse the research evidence; and
- Confirmation of the theory conjecture and the development of a fuller / refined theory.

Chapter four presents the results of the testing and analysis of the research evidence that was collected.

CHAPTER FOUR: DATA ANALYSIS AND DISCUSSION

4.1 Introduction

In the previous chapter the argument for the research approach adopted was developed, and the research methodology was presented. During the data gathering exercise eighteen interviews were conducted with Data Warehouse practitioners, using the semi-structured interview technique. Tape recordings of the interviews were transcribed verbatim into a 130 page document which formed the research evidence for the data analysis. A sample transcript of one of the interviews is attached as Appendix B.

This chapter presents the results of the content and interpretive analysis that was conducted on the research evidence. The objectives of the data analysis are to:

- Determine the validity and level of support for the empirical generalisations; and
- Reveal any additional insights provided by the respondents.

4.2 Demographic Analysis

Table 4.1 below shows a breakdown of the various industry sectors in which the respondents who were interviewed worked. Although five respondents from the banking industry were interviewed, three were from the same bank. Two of these respondents worked on the same Data Warehouse project, while one worked on a different project that was managed separately in a different part of the bank. Both respondents from the mining industry worked for the same organisation and were involved in the same Data Warehouse project.

Table 4.1 The number of respondents from the various industry sectors

	Industry Sector	No of respondents	No of different organisations
1	Retail	4	4
2	Banking	5	3
3	IT product sales and support	1	1
4	Telecommunications	1	1
5	Medical aid administration	1	1
6	Tertiary education	1	1
7	Manufacturing	1	1
8	Mining	2	1
9	IT services (consulting)	2	2
Totals		18	15

4.3 The Interview Process

At the start of each interview the respondents were reminded of the objective of the research, and the concept of Critical Success Factors (CSFs) was explained to them. The respondents were then asked a number of demographic questions, after which they were asked what they believed to be the CSFs for implementing Executive Information Systems (EISs) based on Data Warehouses. Therefore, although all of the respondents had been involved in Data Warehouse initiatives that had a broader purpose than only addressing the information needs of senior executives, the interviews focused on the executive information aspects of Data Warehousing.

To avoid biasing the views of the respondents, the interview guide was not used until the respondents were comfortable that they had covered what they thought were the CSFs. The data gathered, therefore, is a fair representation of the views of the respondents.

4.4 Content and Interpretive Analysis

The research evidence gathered provided a good basis for content and interpretive analysis, and the themes that emerged from the analysis are presented in table 4.2 below. Where appropriate the themes have been grouped together into logical groupings.

Table 4.2 Summary of the content analysis used for the discussion

Logical grouping of themes	Themes	No. of respondents who mentioned a theme
The use of Data Warehousing for EIS purposes	Data Warehouses are used for EIS purposes	1
	Data Warehouses are used to provide information directly to senior executives	5
	The users of a Data Warehouse should be the top decision makers in an organisation	6
The emergence of Data Warehousing	Data Warehousing as a concept is still maturing	5
	There are various interpretations of what a Data Warehouse is	2
	Data Warehouses are used as Operational Data Stores	3
	Data Warehouses are used for Data Mining	3
	Data Marts are used	3
Successful Data Warehouses	Successful Data Warehouses	9
	Unsuccessful Data Warehouses	1

Logical grouping of themes	Themes	No. of respondents who mentioned a theme
The link between the data in a Data Warehouse and the goals and performance measures of the business	There is a need to respond quickly to an emerging competitive threat	2
	There is a need for good quality internal business information	1
	There is a need for a vision of what the Data Warehouse is going to achieve	7
	There is a need to implement the core information that tracks and supports the goals and performance measures of the business	15
	There is a need to include all affected stakeholders	3
	A Data Warehouse allows a 'customer-centric' view of organisational data	3
	A Data Warehouse allows viewing of data across multiple organisations	1
The approach for establishing the system objectives and business information requirements	There is a need to scope and analyse business information requirements properly	2
	The approach depends on current circumstances and the management culture of the organisation	3
	There are four approaches for understanding the system objectives and business information requirements	18
	Orgnisational readiness will dictate which approach is most appropriate	4
	There is a need to use a proven methodology to establish the system objectives and business information requirements	3
The approach for implementing a Data Warehouse	There is a need to use an iterative, prototyping implementation approach	9
	There is a need for identifying and implementing the most important business information first	3
	There is a need for an overall enterprise-wide data and technology architecture	5
	There is a need for a 'big bang' implementation approach	2
	There is a need to follow a proven methodology to implement a Data Warehouse	4

Logical grouping of themes	Themes	No. of respondents who mentioned a theme
The support and commitment of business users and IS/IT staff	There is a need for business buy-in	9
	The business should initiate, drive, and own the Data Warehouse project	15
	There is a need for a senior business champion	5
	There is a need for executive sponsorship	1
	There is a need for a steering committee	1
	There is a reciprocal relationship between the level of commitment by the business and the perceived value of a Data Warehouse	4
	There is a need for continued, long term commitment by business executives	2
	There is a need for IS/IT commitment	6
	There is a need for a full-time team of competent, results-driven business and IS/IT staff on the project	6
	There is a need for good, rigid project management	5
	Commitment is measured by how many resources the business is prepared to allocate, and how much it is prepared to spend	3
	Commitment is measured by how much time senior executives dedicate to defining their information requirements	2
	There is a need for the business to take ownership and responsibility for the quality of data that goes into the Data Warehouse	5
The management of expectations	There is a need to correctly manage the expectations of executives	8
	There is an expectation that meaningful results will be visible within months or weeks	4
	There is an expectation that a Data Warehouse will make up for deficiencies in operational systems	5
	There is an expectation that a Data Warehouse will make jobs easier	1
	There is an expectation that a Data Warehouse contains 100% accurate transaction level data	1
	There is a need to understand that a Data Warehouse is not a technology project	3
	End user expectations are most effectively managed through active involvement, continuous communication and feedback, and effective education and awareness programs	3

Logical grouping of themes	Themes	No. of respondents who mentioned a theme
The management of political and cultural issues	Technology and data ownership should be no different in a Data Warehouse environment than what they are in a traditional IS/IT environment	8
	IS/IT see a Data Warehouse as a direct threat to the control they have over end users	2
	If information represents power, users will not share it	3
	There is a need for a culture of information	5
	An autocratic decision culture can threaten a Data Warehouse initiative	1
	Conflict regarding the choice of technology can become a political issue	2
	The implementation and support of technologies of competing vendors by an outsource partner can become a problem	1
The security of data and information	The importance placed on data and security depends on the culture of the organisation and the industry in which it competes	2
	The approach to the security of data in a Data Warehouse environment should not differ from the approach used with traditional production systems	2
Demonstrated value and benefit	There is a need to demonstrate results in the short term	3
	There is a need for senior business executives to be aware of, and believe in the value of a Data Warehouse	5
	It is difficult to attach quantifiable, tangible benefits to a Data Warehouse	9
	The benefits of a Data Warehouse are not measured because of the difficulty of doing so	2
	It is only possible to see all of the benefits of a Data Warehouse some time after it has been implemented	3
	It is important to provide and demonstrate a Return on Investment (ROI)	11
	It is important to carefully manage the costs	2
	The benefits of a Data Warehouse include: • Identification of new business opportunities; • Ability to substantiate forecasts and suspicions; • Reduction of manual information processing; • More timely access to information; and • Performance of operational systems is not jeopardised.	16

Logical groupings of themes	Themes	No. of respondents who mentioned a theme
	There are unexpected spin-offs and benefits from a Data Warehouse	2
	The measures of success of a Data Warehouse include: • Financial return, specifically ROI; • Increase in usage; and • User dependency on the Data Warehouse.	8
	The value of a Data Warehouse depends on who uses it and how they use it	1
The provision of good quality external and internal information	There is a need for a consolidated, integrated view of critical business information	6
	There is a need for a 'single version of the truth'	7
	The required degree of data accuracy is needed	10
	There is a need for timely access to data	10
	There is a need for reliable data	13
	There is a need for proper 'housekeeping' practices	4
	Data must be at the appropriate level of detail	1
	There is a need for a sound supporting infrastructure of networks, and operational and tactical information systems	6
	There is a need for appropriate front-end tools to provide access to, and display the information needed	3
	There is a need for historical data in the Data Warehouse	1
	Data must be available in a variety of forms	2
	There is a need for business metadata	4
User participation	It is important to involve end users	11
	There is a relationship between user participation and user expectations	3
	A steering committee is an effective mechanism to ensure active user participation	2
	There is a need to carefully select end users	2
	User participation creates a common vision of the scope and objectives of the project	1
Education, training, and support	It is important to educate and train end users	13
	It is important to correctly time the training	3
	There is a need for adequate support personnel	4
	Lack of computer literacy of today's senior executives	4
	Education and training is ongoing	3
	It is important to train IS/IT staff	2
	There is a need for skilled and competent business users	1
	Internet technology reduces the training burden	3

Logical grouping of themes	Themes	No. of respondents who mentioned a theme
	There is a relationship between education and training, and awareness	2
Flexibility of the Data Warehouse	There is a need to accommodate the ongoing addition of data	2
	There is a need for a thoroughly planned, and well designed data architecture	4
	Different users have different information, analysis, and presentation requirements	10
	Internet technology provides flexible access to data in a Data Warehouse environment	4
Ease of use	There is a need for easy to use front-end tools	14
	There is a need for easy access to business metadata	1
	Different levels of functionality and ease of use are required by different users	3
	There is a need for a standard set of core electronic reports	2
	Internet technology is used based on its ease of use	5

The remainder of the chapter discusses the results of the data analysis under headings for each logical grouping of themes. Although some themes are similar they appear in different logical groupings depending on the context in which the respondents referred to them.

The themes have also been split into two major sections. In section 4.5 those themes raised by the respondents that do not relate directly to the empirical generalisations proposed for this research, are discussed. These themes include additional insights provided by the respondents. In section 4.6 those themes that relate to the empirical generalisations are analysed and discussed. Section 4.6 forms the basis of establishing the level of support for the empirical generalisations, which is discussed in greater detail in chapter five.

Throughout the data analysis and discussion, where reference is made to a Data Warehouse or Data Warehousing it implicitly refers to the executive information component of Data Warehousing.

4.5 Insights Provided by the Respondents

This section discusses the themes raised by the respondents that do not relate directly to the empirical generalisations proposed for this research. These themes create the context for the data analysis and discussion in section 4.6, and provide useful additional insights.

4.5.1 The use of Data Warehousing for EIS purposes

Only one respondent, from an organisation in the manufacturing industry, indicated that his had implemented its Data Warehouse with the express intention of using it as an EIS. The reason why only one organisation focused specifically on the EIS component of a Data Warehouse is that most other respondents saw EIS functionality as one of the many purposes of a Data Warehouse. They saw a Data Warehouse as an enabling component of the overall IT infrastructure that supports a broader set of decision support needs, such as those provided by Management Information Systems (MISs), Decision Support Systems, and Data Mining. As one respondent from the retail industry put it:

> "We haven't differentiated between EIS and the Data Warehouse. We see the Data Warehouse as being the core infrastructure that is capable of delivering the required [EIS] functionality."

Twenty eight percent of the respondents mentioned that their Data Warehouses were being used to provide information directly to senior business executives, but indicated that executive users only represent a small percentage of the total number of users. In one case, only the financial executives were receiving data from the Data Warehouse. Eleven percent of the respondents claimed that their executives were receiving data indirectly from their Data Warehouse. Although thirty three percent of the respondents felt that a Data Warehouse should be aimed at the top decision makers in the organisation, it appears that the primary users of a Data Warehouse are middle to upper middle managers, who need access to good quality operational and tactical information.

4.5.2 The emergence of Data Warehousing

Twenty eight percent of the respondents mentioned that Data Warehousing as a concept is still maturing in South Africa, and that it will be a few years before it is properly defined. These respondents stressed that the technology is still evolving rapidly and is not well established.

Due to the emerging nature of Data Warehousing, eleven percent of the respondents believed that there are various interpretations of what a Data Warehouse really is. As one respondent from the banking industry put it:

> "Worldwide no two Data Warehouses are the same. Everybody believes they've got a proper Warehouse; some people are positioning their 'proper' Warehouse at the front end of things, almost in the operational line; other people are positioning their 'proper' Warehouse at the MIS cube, static end of the line; and other people adopt a position in between. A Warehouse is a concept, not a concrete instantiation. There is no such thing as a 'real' Data Warehouse."

This respondent claimed that only once an organisation sees their Data Warehouse as a means of decision support and strategic direction, and not as a source of traditional MIS reports, will it become a 'real' Data Warehouse. Until then its just another operational MIS / reporting tool.

In addition to the variety of interpretations of Data Warehousing, the respondents also mentioned that their organisations were using their Data Warehouses for a variety of purposes:

- Seventeen percent of the respondents indicated that they were using their Data Warehouses as Operational Data Stores. One respondent from the banking industry describes an Operational Data Store as:

  > "... a daily Warehouse. It's current at a recent point in time but it's not an on-line Warehouse."

- Seventeen percent of the respondents mentioned that their organisations were planning to use the data in their Data Warehouses for Data Mining purposes; and
- Seventeen percent of the respondents also indicated that they were using Data Marts (mini, function- or subject-specific Data Warehouses) to meet the specific needs of functional areas within their organisations.

The net effect of the fact that the respondents felt that Data Warehousing is still evolving and maturing is that it will be some time before the most appropriate use of Data Warehousing, and its value, is fully understood.

4.5.3 Successful Data Warehouses

Fifty percent of the respondents regarded their Data Warehouse initiatives as a success, for the following reasons.

- They had received positive feedback from senior executives and business users;
- Those users who needed access to information were getting access to it;
- Users were actively using the Data Warehouse;
- There was a demonstrated Return On Investment (ROI);
- New business opportunities and threats had been identified; and
- There was a change in the way the business operated. For example, a change from a financial orientation to a 'customer-centric' orientation.

Six percent of the respondents did not regard their organisations' Data Warehouses as successes, for the following reasons:

- The Data Warehouse had not changed the way the business operated;
- The power of the Data Warehouse had not been utilised to the benefit of the business;
- There were no success stories; and
- The business was not selling the advantages of the Data Warehouse.

4.6 Evaluation of the Critical Success Factors for Implementing an Executive Information System based on a Data Warehouse

This section analyses and discusses the themes raised by the respondents that relate to the empirical generalisations proposed for this research. It forms the basis for establishing the level of support for the empirical generalisations, which is discussed in detail in chapter five.

4.6.1 The link between the data in a Data Warehouse and the goals and performance measures of the business

The respondents were involved in Data Warehouse implementations that were initiated in response to a variety of business drivers:

- Eleven percent of the respondents indicated that their organisations needed to respond quickly to an emerging competitive threat. One respondent from the banking industry claimed that his organisation's Data Warehouse initiative was driven by a business need to understand its customers better and as quickly as possible, as it faced potentially significant competition from international banks;
- Six percent of the respondents mentioned that the business driver for their Data Warehouses was a pressing need for good quality internal business information; and
- One respondent, from the retail industry, indicated that the primary driver for his organisation to develop its Data Warehouse was to have a cross-functional, process view of its business so that its supply chain could be made more efficient.

Regardless of the specific business driver for a Data Warehouse initiative it is important that the initiative is linked to well defined business goals and performance measures. There must be clarity amongst senior executives of the value of achieving the goals and performance measures, and an associated incentive to pursue them. For example, it is not enough for senior executives to indicate an interest in customer information. There must also be clarity on the value of the customer information, and what business goal it will support. Thirty nine percent of the respondents stressed the importance of having a vision of what the Data Warehouse is going to achieve in the long term, from a business perspective. As one respondent from the banking industry put it:

> "Unless you start by aligning with the business and saying, 'Where do you need to take this business?'; what do you need from a Warehouse to achieve that business objective?', you don't have a hope."

The primary focus must be on the core information that tracks and supports the goals and performance measures of the business, rather than on all of the information that is potentially important. Focusing on the key business drivers forces senior executives to carefully consider what information they absolutely need to run the business, and ensures that only information that has business context is included in the Data Warehouse. Furthermore, it is critically important that the meaning of this core data and the threats and opportunities it identifies, are understood. Eighty three percent of the respondents stressed the importance of identifying and populating the Data Warehouse with this core

data. According to one respondent from the retail industry it is critical that the Data Warehouse initiative:

> ...is driven by the absolutely burning issues within the organisation. These are the problems related to the business that the executives have to solve."

Another respondent from the mining industry stated that:

> "The information that resides in the Data Warehouse must relate to a limited number of key business drivers."

The latter respondent stressed that it is critical that the vision and mission of the business is clear and that both the business and the project team understand what the key business drivers are. Furthermore, this respondent emphasised that a Data Warehouse should provide the data that tracks and supports the short, medium, and long term objectives of the senior decision makers in the organisation.

Lack of planning and a clear link to business goals often results in the inappropriate choice of front-end tools, the development of data models that do not reflect the structure of the business, and the choice of a technology infrastructure that soon becomes inadequate and cannot be expanded. Seventeen percent of the respondents indicated that they had to go back and re-plan, re-model, and re-implement their Data Warehouses because they had not adequately linked their implementation efforts to an overall business purpose, and had not planned for the inclusion of all business critical information.

The goals and performance measures of senior executives seldom focus on one functional area within the business, to the exclusion of the organisation as a whole. If a functional view is taken there is a significant risk that critical information will be omitted from the Data Warehouse, or not planned for in the long term. Therefore, as stressed by seventeen percent of the respondents, it is important to include all the affected stakeholders in identifying the critical business information to be included in the Data Warehouse.

By allowing the business to be viewed across business functions and boundaries the data in a Data Warehouse can provide opportunities to analyse and understand products, services, customer behaviour, and customer preferences better. One of the reasons cited by seventeen percent of the respondents for the attractiveness of a Data Warehouse is that it allows them to take a 'customer-centric' view of their organisational data. The respondent from the medical aid administration industry claimed that they had:

> "...made a shift in the business from a financial focus to a 'patient-centric' focus..."

Furthermore, as one respondent from the retail industry indicated, the cross functional data in a Data Warehouse can allow senior executives not only to view product

portfolios, suppliers and sales patterns across a single organisation but also across multiple similar organisations. This allows collective bargaining to be done using all of the businesses as a collective reference.

Senior decision makers in an organisation must be absolutely clear on what their goals and performance measures are, and must be committed to achieving them. Without this clarity and commitment there will be no incentive for them to use data that has been built into a Data Warehouse to track and support their goals and performance measures. However, if they do have this clarity but the data in the Data Warehouse does not relate to their goals and performance measures, it will not have any context for them, and there will still be no incentive for them to use it. As one respondent from the IT services industry put it:

> "It [the data] must be something that they want to use, it must be part of their job."

If the data in a Data Warehouse is linked to the goals and objectives of the business, it will provide senior executives with useful information that they can use to guide the organisation strategically. Furthermore, it will provide them with a mechanism to reflect back on how well they have achieved the goals and objectives. By being able to monitor trends senior executives can analyse what has gone wrong, what opportunities have been missed, and what can be done to address shortcomings. This may even result in a change in the overall business strategy.

4.6.2 The approach for establishing the system objectives and business information requirements

It is important to use the correct approach for establishing the system objectives and business information requirements, for the following reasons:

- As stressed by eleven percent of the respondents, it is critically important to scope the project and analyse the business information requirements properly. One respondent from the IT services industry argued strongly in favour of using automated software tools for understanding and building the data model because:

  > "...there's a limit to how much of the data model you can keep on a piece of paper. Also, you will have difficulty moving from the logical data model to the physical data model."

- Seventeen percent of the respondents claimed that the approach taken to understand the business' information requirements depends on the current circumstances and management culture of the organisation. As one respondent put it:

  > "...within each organisation things are different. Some things you need to do differently."

Seventeen percent of the respondents mentioned that they had initially taken the wrong approach to identifying the business' information requirements, and had to change it to prevent the project from failing.

The respondents proposed various approaches for understanding the system objectives and business information requirements. The first approach, used by thirty three percent of the respondents, involves identifying and prioritising specific opportunities and 'burning issues' that are deemed important by the business. There is not necessarily a tangible benefit associated with resolving these issues. As one respondent from the mining industry put it:

> "You need to look for specific once-off opportunities that you can address. This is a better approach than to look at somebody's Key Performance Areas and Critical Success Factors..."

The second approach, used by twenty two percent of the respondents, involves deriving the system objectives and information requirements directly from the business goals, objectives, CSFs, Key Performance Areas, and Key Performance Indicators of the senior executives. Using this approach executives and senior managers across the organisation are asked what they think are the most important issues facing the business and where they see the business in the future. The issues are prioritised, CSFs are defined, and measures of success are developed. Once this has been done the information required to track and support the CSFs and measures are defined, and this forms the basis of the data that is used to populate the Data Warehouse. This approach usually focuses on subject areas such as customers or products, rather than on functional areas such as marketing, finance, or sales. Although eighty three percent of the respondents stressed the importance of implementing the core information that tracks and supports the goals and performance measures of the business, only twenty two percent of the respondents derive this information explicitly from these goals and performance measures. Although it was not specifically mentioned, it is likely that most respondents believe that by identifying the information needed to solve specific business problems and issues, they are implicitly identifying the information needed to track and support the business goals and performance measures.

A third approach, used by twenty two percent of the respondents, is a combination of the first two. In this approach the Data Warehouse team identifies the information needed by senior decision makers to address specific short or long term business issues, provided there is some quantifiable financial benefit associated with resolving the issues. One respondent from the banking industry mentioned that in their case, a team of IS/IT and business staff from the bank undertakes a Business Discovery Process to see how the data in the Data Warehouse can be used better to change the business or realise some value. Only opportunities that promise significant financial returns as revealed by a complete business benefits analysis, and that the business is prepared to pay for, are pursued.

A fourth approach, which was pursued by twenty two percent of the respondents, involves basing the information requirements of senior business managers and executives

on what is perceived to be important to them, by individuals within the business. In eleven percent of the cases functional experts from the business drove this approach. In six percent of the cases it was driven solely by IS/IT, with little business input, while in another six percent of the cases it was driven by junior level staff who based the business information requirements of the senior executives on the paper reports used by these executives. In the cases where it was driven by IS/IT the respondents admitted that their Data Warehouses were initially not a success. However, as the business became aware of how valuable the data in the Data Warehouse was, the more it used this data. This particular approach requires a clear understanding of the business and the executives' information needs. Unfortunately, even if the information requirements can be derived in this way the lack of senior management involvement is likely to create unrealistic expectations, lack of awareness, and associated problems with long term ownership and commitment to the initiative.

The difference between the various approaches discussed above can be subtle. There is a risk that the first, third and fourth approaches will focus on short term issues that are centered around achieving goals that are operational in nature, and that may not have anything to do with the overall long term strategic goals of the business. The second approach takes a broader, long term view aimed at assisting the business pursue its chosen direction based on strategic, rather than operational goals. The more 'mature' the management style of an organisation's senior executives the more suitable the CSF based approach becomes. Ultimately, as twenty two percent of the respondents pointed out, the level of organisational 'readiness' will dictate which approach is most appropriate

Seventeen percent of the respondents stressed the importance of using a proven methodology to establish the system objectives and business information requirements. The IT product sales and support and IT services industries tend to use methodologies extensively, and all of the respondents that strongly supported the use of a methodology were from these industries. One respondent from the IT services industry justified the use of a methodology by claiming that the most successful practitioners in the Data Warehousing environment all follow very similar methodologies. This respondent claimed that most methodologies are based on the first approach mentioned above. Although there is significant merit to the application of a *proven* methodology, it should be approached with caution. A methodology should provide overall guidance to ensure that all the applicable issues are considered, and in so doing should highlight and help manage potential risks. However, it should be sufficiently flexible to allow one of many approaches to be adopted depending on the specific needs of each organisation.

4.6.3 The approach for implementing a Data Warehouse

The respondents proposed two main approaches for implementing a Data Warehouse. The first approach, supported by fifty percent of the respondents, is an iterative prototyping approach. Using this approach the whole project is broken up into logical steps and each step is implemented as a distinct, focused project with its own

deliverables. Each of these steps is usually a subject area on its own such as customer or product. The reasons for adopting a prototyping approach are:

- To demonstrate visible, 'quick win' short term results to the business to ensure buy-in, and continued business commitment;
- To be able demonstrate value on an ongoing basis as each iteration delivers results. According to one respondent from the IT services industry:

> "I try not to make my projects run longer than ninety days so that we don't lose momentum and the users don't get disillusioned."

Furthermore, the respondent from the tertiary education institution stressed that:

> "If the users can't see something, it very difficult for them to do it..."

- By implementing the Data Warehouse by subject area it can be divided up into manageable phases and the risk of failure can be reduced. Furthermore, since there are so few experienced Data Warehouse practitioners it allows both the users and the implementation team to gain valuable experience while they are building the first few prototypes.

It is important to ensure that the most pressing business information needs are met first, and that meaningful results can be delivered to the business as soon as possible. Therefore, seventeen percent of the respondents raised the importance of identifying and implementing the most important business information first, perhaps as part of the implementation of the first few prototypes.

Of the respondents who advocated a prototyping approach, fifty six percent of them indicated that this approach should be taken in the context of an overall enterprise-wide data and technology architecture. The reasons for this are to:

- Ensure hardware and software scalability. There tends to be a rapid increase in the usage and number of users of a successful Data Warehouse. Therefore, adequate provision must be made for substantial future growth and expansion; and
- Achieve efficient data integration as the Data Warehouse is implemented. This is particularly important when the project is broken up into separately managed phases where each of the phases covers the data associated with a specific subject area or business problem.

To ensure that they developed their Data Warehouse within a 'best practice' architectural framework, the respondent from the telecommunications industry mentioned that his organisation had bought a pre-defined data schema from one of the large Data Warehouse vendors. This approach has the following additional benefits:

- The data schema does not have to be developed from first principles;
- The Data Warehouse team can learn from the combined experience of the many teams that contributed to the development of the data schema; and
- The Data Warehouse can be implemented more quickly.

The second implementation approach, supported by only eleven percent of the respondents, is the so-called 'big bang' approach. Using this approach, all of the information requirements of all of the senior executives pertaining to all the organisation's products, services, suppliers, and customers, is included in the Data Warehouse at once. One respondent that used this approach claimed that is was adopted in response to a significant business need for good quality operational data in the short term. The respondent did, however, admit that the implementation effort only focused on the most important business information, rather than on all of it. B on this admission it is difficult to determine whether this respondent did, in fact, use g bang' approach, or some form of prototyping. According to another respondent that claimed to have used a 'big bang' approach:

> "Vendors will tell you that you can build a Data Warehouse or a Data Mart in three months, and they are wrong. You can build one tiny fragmented view, in one part of the business in three months, but whether that actually helps your business is questionable. We found that typically if you go into a big new subject area it takes you six to nine months to do that work."

The view of the latter respondent must be seen in the context of the objective of his organisation's Data Warehouse initiative, which was to provide sufficient data to optimise the entire supply chain of the business. The respondent is employed by one of the largest retailers in South Africa and it has a large number of isolated legacy systems. As the respondent put it:

> "In a two year period we built data from fourteen very big legacy systems into our Data Warehouse."

Although a pressing business need may call for a 'big bang' approach there are significant risks associated with it. For example:

- Depending on the scope of the project and the size of the organisation, there may be large volumes of data involved, and the simultaneous inclusion of all of this data in a Data Warehouse may make the project unmanageable; and
- It may be some time before all the necessary data is included in the Data Warehouse, which increases the risk that end users will become disillusioned and lose interest in the project, before it delivers any real value to the organisation.

Twenty two percent of the respondents stressed the importance of using a proven methodology to implement a Data Warehouse. One respondent from the IT services industry claimed that:

> "...if you don't follow a set methodology then there is a good chance that you are not going to make it."

Fifty percent of these respondents mentioned that the methodology should cover every aspect of the implementation process, from understanding the business information requirements, to the post implementation review.

A methodology-driven approach can be very useful, particularly as a tool to assist the co-ordination of the myriad activities that take place simultaneously during the implementation of a large Data Warehouse. It can also ensure that crucial deliverables are not omitted. As stated in section 4.6.2, however, a methodology should be sufficiently flexible to allow the approach most appropriate to the needs of the business, to be followed.

4.6.4 The support and commitment of business users and IS/IT staff

Fifty percent of the respondents raised the importance of business buy-in. Respondents felt that without buy-in from senior executives, it is extremely difficult to obtain the required support and commitment, and saw buy-in as a prerequisite to support and commitment. Buy-in depends on whether the senior executives agree that there is value and benefit, and consequently merit, in pursuing a Data Warehouse initiative. Furthermore, the business is only likely to initiate, drive and own a Data Warehouse project when it believes in the value of a Data Warehouse. Therefore, as twenty two percent of the respondents pointed out, there is a reciprocal relationship between the level of commitment by the business and the perceived value of a Data Warehouse initiative.

Eighty three percent of the respondents stressed the importance of having the business, rather than IS/IT, initiate, drive and own a Data Warehouse project. As one respondent from the banking industry put it:

> "A Warehouse that doesn't have its mandate from the business is dead."

According to another respondent from the retail industry:

> "...you've really got to have somebody at the top to drive it. If it's not driven from the top it's very difficult."

One respondent from a bank in which the Data Warehouse was initiated and driven by IS/IT felt that, at least initially, it is appropriate for IS/IT to sponsor a Data Warehouse project. The reason for this, he felt, was that the benefits of a Data Warehouse are not visible for a few years. This particular case serves as a good example of why the business should initiate, drive and own a Data Warehouse project. The respondent complained of a lack of awareness in the business community, of what information was available in the Data Warehouse, and what the business value of this information was. The respondent also reported that there was some confusion as to where the responsibility for custodianship, ownership, and the quality of the business data lay. This respondent also stressed that the business should drive the project, once it has been initiated.

An issue associated with the commitment of senior executives - the role and responsibilities of those involved in a Data Warehouse initiative. Although respondents called for the involvement of business champions, business sponsors, and steering committees, they were not clear on what the roles and responsibilities of these entities should be. For example, twenty eight percent of the respondents stressed the importance of having a senior business champion, such as the Managing Director, while six percent of the respondents stressed the importance of seeking executive sponsorship from the business community, to control and lead the Data Warehouse initiative. Another six percent of the respondents felt that a CSF for the implementation of a Data Warehouse is the creation of a steering committee that consists of people with authority in the organisation, such as the MIS Executive, the Managing Director, the Training Executive, the Marketing Executive, and the Operations Executive. However, those respondents that stressed the importance of a steering committee only mentioned that it should be responsible for the overall guidance of a Data Warehouse initiative, and that it should have the authority and credibility to enforce its decisions. Only one respondent mentioned that an executive sponsor should be:

"Somebody with a fair amount of influence, a decision maker."

The inherent problem with a steering committee is that it is a mechanism for collaborative decision making, based on consensus. If two or more influential committee members strongly disagree on an issue, the effect can be that no decision is taken, or a sub-optimal compromise is made. This can undermine the credibility of the steering committee as a whole. Another problem is that the decision cycles of a steering committee, if not managed well, can be long and this may create unnecessary delays at critical times during the project.

Eleven percent of the respondents indicated that a CSF for a Data Warehouse initiative is continued, long term commitment by business executives. Although executives may initially buy into a Data Warehouse project by committing time and financial resources to its development, there is still a risk that it will fail in the long term if there is not sustained investment. One of the reasons that sustained investment is necessary is that as the business changes over time, its information requirements will change and the Data Warehouse will have to be continually enhanced, or occasionally rearchitected, to accommodate these changes. Another reason is that as the usage of the Data Warehouse increases there will be a need to upgrade its capacity and increase the number of resources dedicated to supporting it and its users.

Six percent of the respondents claimed that long term commitment depends on demonstrated ongoing value and benefit to the business. These respondents also claimed that there is a risk that if the Data Warehouse has demonstrated a significant once off return the business may be content with this return and focus its investment efforts in other areas. As one respondent put it:

> "The business could say: 'This is a wonderful thing and has given me a huge ROI of three hundred percent. Why do I need to throw more money at it - its already working?'"

Commitment extends beyond the senior business executives, managers and other end users to IS/IT staff as well. Thirty three percent of the respondents felt that it is equally important that IS/IT resources are also committed to the Data Warehouse initiative. The respondent from the medical aid administration industry claimed that:

> "IT can be the biggest barrier to the success of a Data Warehouse, it can make or break the Data Warehouse. If IT is not keen then don't start."

The business often comes to depend very heavily on the data in a Data Warehouse, and on its reliability and continued availability. Therefore, as thirty three percent of the respondents indicated, it is important that there is a full-time team of competent, results-driven business and IS/IT staff on the project. Seventeen percent of the respondents also felt that a Data Warehouse project is too important and demanding to be a part-time job. Putting together the best team on a full-time basis may be particularly challenging to achieve in the light of the acute shortage of skilled and competent IS/IT resources, especially in the Data Warehouse environment. Furthermore, the most appropriate business staff to have on a Data Warehouse project are often the most competent, and consequently there are great demands placed on them by the business to perform their normal business functions. The level of commitment of senior executives is often tested when it comes to releasing staff to work on a Data Warehousing project.

Twenty eight percent of the respondents raised the importance of having good, rigid project management. The respondent from the medical aid administration industry stressed that:

> "Good project management is one of the biggest areas you have to get right."

Seventeen percent of the respondents felt that project management has to be full-time, while six percent felt that it could be part-time and ad-hoc.

The respondents proposed three different ways in which the level of commitment of senior executives can be measured. The first measure, supported by seventeen percent of the respondents, is how many competent resources the executives are prepared to allocate to the Data Warehouse initiative, and how much they are prepared to spend on the initiative, including the training of end users and IS/IT staff. One of the respondents from the retail industry stressed the importance of having Information Providers or Power Users within the business who can access and analyse the data in the Data Warehouse on behalf of the business.

The second measure, supported by eleven percent of the respondents, is how much time and effort senior executives dedicate to defining their information requirements. These

respondents stressed that it is critically important that senior executives make the time to define their own information needs since, as one respondent from the mining industry put it:

> "The executives steer the organisation and they need to critically evaluate the information *they* need to be able to do this."

The third measure, supported by six percent of the respondents, is the extent to which senior executives have processes put in place to ensure that the business, as owners of its information, supports the Data Warehousing initiative. One of the respondents from the banking industry mentioned that one of the most difficult tasks associated with Data Warehousing is obtaining data from source systems when the business owners of these systems, and the IS/IT staff who are responsible for their maintenance, are not committed to extracting the data and passing it on to the Data Warehouse team.

The business should take ownership and responsibility for the quality of data that goes into the Data Warehouse. If the quality of the data that is fed from source systems into the Data Warehouse is poor (for example, not current or inaccurate) then the Data Warehouse itself will not provide good quality data. This does not, however, mean that IS/IT is not responsible for ensuring that good 'housekeeping' practices are in place to correctly update the Data Warehouse with the data it receives from source systems, and to ensure that the data in the Data Warehouse is available when required. Twenty eight percent of the respondents raised the issue that the business, and not the Data Warehouse team, owns and is responsible for the quality of its data.

The issue of the support and commitment of senior business executives is multi-dimensional and can be very sensitive. Senior executives are unlikely to fully commit to a Data Warehouse project until they fully appreciate its business value. However, the value of a Data Warehouse is unlikely to materialise without full commitment from senior business executives. The link between value and commitment can be difficult to create because, as twenty two percent of the respondents pointed out, it can be difficult to quantify the benefits of a Data Warehouse before implementation. Ultimately, senior business executives may be required to make a 'leap of faith' regarding the value and benefits they will receive from a Data Warehouse.

4.6.5 The management of expectations

Forty four percent of the respondents stressed the importance of correctly managing the expectations of end users, in particular those of executives. Eleven percent of the respondents specifically cautioned against over-selling EIS and Data Warehousing concepts, and thereby creating expectations that cannot be delivered against.

Six percent of the respondents claimed that executives are legitimately disillusioned with EIS because such high expectations have been created that have never been met.

The respondents mentioned that four different expectations are held by end users when a Data Warehouse is implemented. The first, mentioned by twenty two percent of the respondents, is that meaningful results will be visible within a few months, or even weeks. According to the respondent from the tertiary education institution:

> "We managed to deliver in eight months. If we had done it in longer we would have had a serious problem, we would have missed the boat and we would have lost the end user."

Six percent of the respondents claimed that vendors who make unrealistic promises to the business often create this particular expectation. Many vendors do make optimistic claims regarding the time it will take to deliver, but they base their claims on well-defined generic subject areas that they are familiar with, such as products or customers. However, if one of these subject areas needs to be adapted to the specific circumstances of an organisation, it is usually regarded as a scope change by the vendor, with associated time delays, and cost increases. An organisation with little or no Data Warehousing experience, and that relies heavily on input and guidance from external vendors and consultants, is more susceptible to this type of problem.

The second expectation, mentioned by twenty two percent of the respondents, is that a Data Warehouse will make up for deficiencies in operational systems, particularly with respect to the quality of data that will become available. However, since a Data Warehouse depends heavily for its success on a good infrastructure of supporting operational systems that provide good quality data, it is going to highlight deficiencies in these systems rather than alleviate them. Furthermore, if these deficiencies are not addressed there will continue to be a need for good quality operational data throughout the business, and this data will continue to be sought in the Data Warehouse.

The third expectation, mentioned by six percent of the respondents, is that a Data Warehouse will make the jobs of end users easier. This will only be the case if the end users have actively been involved in specifying their information requirements so that the data in the Data Warehouse is relevant to their jobs.

The fourth expectation, mentioned by six percent of the respondents, is that a Data Warehouse will contain perfectly accurate transaction level data, rather than selected management decision support data. In most instances the timeliness and relevancy of decision support data for senior managers is more important than its accuracy. It is, therefore, critically important that the Data Warehouse is correctly positioned with respect to the Transaction Processing Systems in the organisation, and that its goals, purpose and scope are adequately communicated throughout the business.

Seventeen percent of the respondents felt that business users and IS/IT need to understand that a Data Warehouse is not a technology project. One respondent from the mining industry admitted that a Data Warehouse initiative does involve significant IS/IT effort, but stressed that this is not the challenge:

> "The challenge is making sure that the business understands it is the only one that can interpret what's hidden in the Data Warehouse. The business is the only one that can translate the data into meaningful information."

One bank avoided creating unrealistic expectations by implementing its Data Warehouse *before* launching an awareness campaign. It based its awareness campaign on an existing capability to deliver. While this approach may avoid creating unrealistic expectations its lack of user involvement introduces the following risks that increase the likelihood of failure:

- A lack of understanding within the business of what data is in the Data Warehouse, how it can be used, and where it comes from;
- A lack of appreciation by the business of the value and risks associated with the use of the data in the Data Warehouse; and
- A lack of ownership of the data by the business.

Seventeen percent of the respondents felt that end user expectations could most effectively be managed through active user involvement, continuous communication and feedback, and effective education and awareness programs. Furthermore, seventeen percent of the respondents felt that there is a direct, reciprocal relationship between user expectations and user participation.

While the need for user involvement, continuous communication and feedback, and effective education and training was recognised by the respondents, these initiatives can be difficult to realise. All of these initiatives require the undivided attention of end users, but if the end users do not see the value of committing time and effort to them, they will avoid becoming involved in them.

4.6.6 The management of political and cultural issues

Forty four percent of the respondents mentioned that there are significant ownership issues associated with the implementation of a Data Warehouse. Technology and data ownership should be no different in a Data Warehouse environment than what it is in a traditional IS/IT environment. The business should always own its data, regardless of where this data resides. IS/IT can own and operate the supporting technology infrastructure, and often serves as the custodian of business data, rather than as owner of it. The minimum acceptable level of service expected by the business from IS/IT can be stipulated in Service Level Agreements between the business and IS/IT. The respondent from the manufacturing industry provides a good example of a failed attempt by an organisation to delegate its responsibility for information ownership, by not being in a position to provide the necessary authority to allow this responsibility to be assumed. His organisation created a Business Information Department and made it responsible for initiating, driving and owning business systems on behalf of the business. This department was meant to assume the role of business specialist, to facilitate the establishment of the business' information requirements. It was, however, facing

significant resistance from the business and was finding it very difficult to build its credibility, as it had little political power and did not own any business information.

The respondents mentioned six significant political and cultural issues that can lead to the failure of a Data Warehouse initiative. The first issue, raised by eleven percent of the respondents, is that IS/IT staff often see the implementation of a Data Warehouse as a direct threat to the control they have over end users. By empowering end users to directly access their own data the business is less reliant on IS/IT for this data. The respondent from the product sales and support industry claimed that:

> "...you need an open-minded IT department or an IT manager who's not afraid that by putting in the system he is going to lose some of his credibility or his control within an organisation."

The second issue relates to the fact that one of the distinguishing features of a Data Warehouse is that it provides access to data that crosses organisational boundaries However, seventeen percent of the respondents felt that if users who own and control business information perceive that by sharing this information it will undermine their political power, it will be used against them, or it will expose poor practices in their areas of responsibility, they will not willingly share it.

The third issue, raised by twenty eight percent of the respondents, is that the success of a Data Warehouse initiative depends on a culture of information within the organisation. The establishment of a culture of information, however, goes beyond the implementation of a Data Warehouse. A culture of information involves recognising and rewarding the sharing of information throughout an organisation so that it can contribute to an increase in knowledge and organisational learning. Therefore, the sharing of information should be actively encouraged by making the necessary financial and human resources available and by embedding the sharing of information in the performance management systems of the organisation. One of the respondents from the mining industry indicated that the lack of an information culture in his organisation was possibly one of the reasons why their Data Warehouse initiative had been a struggle. The respondents who stressed the importance of an information culture also stressed that it is one of the most difficult changes to successfully implement, particularly when senior executives are not completely committed to it.

The fourth issue, mentioned by six percent of the respondents, is that an autocratic decision culture can threaten the success of a Data Warehouse initiative. A problem can arise when senior executives are afraid of, or are not used to empowering users to make business decisions. In such cases if a Data Warehouse is seen to be an effective empowering tool for staff at lower levels in the organisation, senior executives will actively resist implementation efforts and will not cooperate with information gathering exercises.

The fifth issue, mentioned by eleven percent of the respondents, can arise if IS/IT is divided regarding the choice of the technology for the Data Warehouse. This issue can

relatively easily be resolved if there is an established IS/IT strategy that provides clarity on the technology direction of the organisation, particularly when this strategy is closely aligned to the business strategy.

The sixth issue, raised by six percent of the respondents, can arise when outsource partners are required to either implement or support, or allow the implementation and support of technologies of competing vendors. In such cases the outsource partners may feel threatened by the presence of the competing vendor in 'their' domain. Often the best way to manage such a situation is to reinforce the principle that the business drives the most appropriate technical solution, not the vendor.

Political and cultural issues within an organisation can be subtle, yet powerful. Political issues can arise when a technology, regardless of whether it is a Data Warehouse or not, does not support the decision culture of senior executives in an organisation. The implementation of a technology may be the catalyst for changing the culture, but in itself will not be enough. Furthermore, even if it does form the basis of successful change, it may still fail if it is seen as the source of political leverage or sensitivity.

4.6.7 *The security of data and information*

Although thirty nine percent of the respondents raised the importance of ensuring that adequate security is in place to control access to the data in the Data Warehouse, the issue of the security of data and information was not discussed in depth.

Eleven percent of the respondents stressed that the importance placed on data and information security depends on the culture of the organisation, and the industry in which it competes. For example, the banking industry is bound legally and ethically to keep specific client information confidential. One respondent from the IT services industry claimed that, in general, organisations are beginning to feel less proprietary about their information as they begin to see the value of sharing it, even with their suppliers and customers. Seventeen percent of the respondents felt that a Data Warehouse should be implemented with a philosophy of information sharing. As one respondent from the banking industry put it:

> "Everything needs to be transparent. To gain knowledge you must share your information."

Eleven percent of the respondents felt that the approach to the security of data in a Data Warehouse should not differ from the approach used with a traditional production system. Certain information, such as payroll information, will always be confidential and should be treated as such. One respondent from the mining industry pointed out that:

> "It is purely a matter of understanding not only the power, but the danger of giving people access to the data."

The level of security of data in a Data Warehouse should be dictated by a legitimate business need, such as client confidentiality or legal requirements. However, there is a danger that the cultural or political issues within an organisation can dictate the level of security, and where these issues limit the sharing of information, they also undermine the potential value of a Data Warehouse.

4.6.8 Demonstrated value and benefit

Twenty eight percent of the respondents mentioned that it is important that senior executives in the business are aware of, and believe in the value of the Data Warehouse, and do not merely see it as a cost or as an overhead. For this to happen mechanisms must be developed to create the link between a Data Warehouse initiative and its value. Measures must be developed so that the business can associate tangible business benefits directly with the information provided by the Data Warehouse. For example, measures such as the value of being able to optimise stock management, the value of understanding the sales patterns of product ranges, or the value of understanding the buying patterns of certain clients. Furthermore, when the use of the Data Warehouse has resulted in a benefit to the business, this benefit should be formally communicated to senior executives.

Thirty three percent of the respondents indicated that buy-in and subsequent continued business support and commitment depends on how much benefit can be demonstrated and how soon this benefit can be shown. One respondent from the retail industry claimed that when selected groups of users are using the Data Warehouse, and are deriving value from it, this will encourage other users to use it as well. Furthermore, satisfied users will also sell the benefits to the rest of the organisation.

Fifty percent of the respondents indicated that it is difficult to attach quantifiable, tangible benefits to a Data Warehouse initiative. One respondent from the banking industry highlighted this by saying:

> "Everybody has an instinctive feeling that the Data Warehouse is worth a lot. Unless you've got figures on a graph it remains a warm feeling."

The respondent from the tertiary education institution claimed that their Data Warehouse initiative is a success, but that:

> "There are unfortunately no quantitative ways that I can tell you it's a success."

There are three primary reasons why the benefits of a Data Warehouse initiative are difficult to quantify and measure. The first reason, mentioned by eleven percent of the respondents, is that it is often very difficult to isolate the benefits that are directly attributable to a Data Warehouse, especially since the implementation of a Data Warehouse is usually done in conjunction with other business improvement initiatives.

These respondents felt that the benefits of a Data Warehouse are too difficult to measure, and therefore did not attempt to measure them.

The second reason, mentioned by seventeen percent of the respondents, is that it is often only possible to see all of the benefits of a Data Warehouse some time after it has been implemented. The business must therefore make a 'leap of faith' that their investment in a Data Warehouse is going to provide some return. As one respondent from the IT services industry put it:

> "...there is no way of knowing how it's going to affect everybody. We all think that it's going to make everybody's life easier, and increase productivity, but you don't know for sure how much money its going to save you."

The third reason, mentioned by six percent of the respondents results from the level of management that uses the data in a Data Warehouse. Senior managers and executives make strategic decisions based on intuition and 'gut feel' rather than on hard facts. They will look at a series of trends and projections and make high level strategic decisions that have results that are often difficult to quantify up front. Tactical and operational managers, on the other hand, will use standard reports from operational systems to make decisions based on hard facts, and these decisions usually have tangible outcomes.

Despite the difficulty of quantifying the benefits, sixty one percent of the respondents stressed the importance of proving and demonstrating a ROI, or at least some financial benefit, from a Data Warehousing initiative. Often future expenditure on a Data Warehouse depends on the demonstration of financial returns. Seventeen percent of the respondents claimed that continued, demonstrated ROI is the most powerful way of demonstrating the long term value of a Data Warehouse, and that it is also the only way of ensuring that business executives continue to invest in it.

To satisfy the need of the business for demonstrated bottom line returns from their Data Warehouse initiative, twenty two percent of the respondents indicated that they only pursue projects that promise large ROI. For example, the respondent from the medical aid administration industry stated that their financial systems are not on the Data Warehouse because these systems do not generate any financial returns. This respondent stressed that:

> "Although we believe in the value of the Data Warehouse we want to, we have to, prove this value."

One of the respondents from the banking industry claimed that they will not pursue any projects for the business unless it is accompanied by a complete Business Benefits Analysis, and unless the business is prepared to pay for the effort involved in solving its problems. According to this respondent:

"The deliverables from the Business Benefits Analysis are the business drivers. Establishing the business drivers before doing the development work is a Critical Success Factor."

The above approach has the following advantages:

- The business is forced to calculate the potential ROI associated with the solution of its problems, *before* any work is actually done to solve these problems;
- It ensures that adequate measures are put in place to evaluate whether the expected ROI has been achieved once a business problem has been solved; and
- It prevents the Data Warehouse from being seen as an operational reporting system and it forces the business to look for potential opportunities and value that may be revealed by the data.

There are, however, two main disadvantages of this approach:

- Potentially significant business opportunities and unexpected benefits can be missed by focusing solely on defined problems with defined outcomes, and that yield only financial results; and
- If the only measure of success of a Data Warehouse is its contribution to the bottom line, there is a danger that only solutions to short term financially oriented problems will be sought.

Eleven percent of the respondents indicated that part of demonstrating value to the business is carefully managing the costs. There was a particularly strong focus on the cost aspect by the respondent from the manufacturing industry who was involved in a Data Warehouse initiative that was not driven by the senior executives of the organisation. This focus may have resulted from the fact that the respondent did not have a mandate from the senior executives of the business to develop the Data Warehouse. In this case there is a significant risk that even if the Data Warehouse does have business value it may still be vetoed. This will happen if the senior executives perceive the development of the Data Warehouse to be insubordinate, or to indicate that there is a lack of confidence in their ability to identify and use the information they need to guide the business.

The respondents indicated that there are four primary benefits of a Data warehouse initiative. Furthermore, eleven percent of the respondents indicated that there were also unexpected spin-offs and benefits from a Data Warehouse initiative. These unexpected benefits include people thinking differently about the business, and improved workflow processes.

The first primary benefit of a Data Warehouse, mentioned by seventeen percent of the respondents, is that a Data Warehouse allows the identification of new business opportunities and new niche markets. By its nature, a Data Warehouse stores historical data and data that is integrated across a variety of disparate systems that span traditional business functions. Therefore, as claimed by eleven percent of the respondents, it allows forecasts and suspicions about customer behaviour, product sales patterns, and the effect

of external and internal variables on the business to be substantiated or disproved. As the respondent from the medical aid administration industry put it:

> "In the past we have been good at making predictions without a Data Warehouse because of the quality of the people making the predictions and their vast experience, but now we can back these predications up."

The second benefit, mentioned by eleven percent of the respondents, is that a Data Warehouse reduces the manual, boring, time-consuming process of extracting management information from operational systems. This frees up scarce and expensive IS/IT resources to perform other, more appropriate tasks.

The third benefit, mentioned by forty four percent of the respondents, is that a Data Warehouse provides more timely access to information. It is quicker to access the data in a Data Warehouse using a front-end tool than it is to request and wait for a report to be extracted by IS/IT. This can significantly increase the timeliness of data. The respondent from the IS/IT product sales and support industry claimed that:

> "...timely access to data is the key justification for implementing a Data Warehouse."

The fourth benefit, mentioned by six percent of the respondents, is that by storing and analysing decision support data in a Data Warehouse environment, the performance of operational systems is not jeopardised.

The respondents also mentioned the following four measures of success of a Data Warehouse initiative:

- Financial return, specifically ROI. This was mentioned by seventeen percent of the respondents;
- Increase in usage, which was mentioned by eleven percent of the respondents;
- Users have become so dependent on the data that the system has become mission critical. Seventeen percent of the respondents, all from the retail industry, claimed this to be a measure of success of a Data Warehouse initiative; and
- Certain business questions and 'burning issues' cannot be answered or addressed without the integrated, consolidated data that is provided by a Data Warehouse. Six percent of the respondents felt that this was a measure of success.

One respondent from the mining industry was, however, careful to point out that Data Warehouses are well suited to the solution of information based problems, but not all problems.

There are undoubtedly myriad benefits associated with Data Warehousing. However, a Data Warehouse is not the panacea for the information and decision support needs of an entire organisation. For example, it does not replace the need for detailed operational reports provided by Transaction Processing Systems. Furthermore, it does not solve business problems on behalf of the business. It does, however, provide useful historical,

subject area specific, detailed data that spans organisational boundaries. The value of this data depends on how it is analysed and interpreted by senior executives and specialists from within the business. As one respondent from the retail industry put it:

> "Data in a Data Warehouse on its own is not worth a lot. What you have to do with your Data Warehouse is look for people who can use the data to tell you something you didn't know, or to look at the data in a slightly different way and to use that insight to leverage change in the business. It is these business changes and the new things that you didn't know about your business that really make money."

4.6.9 The provision of good quality information

The quality of information should be seen in the context of its various characteristics. These characteristics are availability, reliability and confidentiality. The reliability of an information element depends on its accuracy, completeness, currency, validity, timeliness, and auditability. In general, the respondents did not discuss the quality of information in terms of its characteristics but did refer specifically to the requirement for the reliability of data in its broadest sense, as well as to the requirement for accuracy and timeliness.

Fifty five percent of the respondents stressed the importance of ensuring that the data in a Data Warehouse has the required degree of accuracy. However, the degree of accuracy of a data element depends on its intended use, as users, other systems, and other applications can access a Data Warehouse. On the one hand respondents claimed that all users do not have the same requirement for data accuracy. For example, often strategic information can be less accurate than operational information. This was illustrated by one of the respondents from the banking industry who claimed that eighty percent accurate and monthly data was adequate for the strategic target-market decisions made by the banks' marketing department, while the financial users demanded far more accurate and up-to-date information. On the other hand, some respondents claimed that the objective should always be to have perfectly accurate data in the Data Warehouse. For example, one respondent from a traditionally conservative mining company, claimed that although a lot of data in a Data Warehouse may only be summary data, whatever data is there should be perfectly accurate. It appears, therefore, that the requirement for the accuracy of data depends not only on the intended use of the data, but also on the culture of the organisation.

Fifty five percent of the respondents mentioned that timely access to data is critically important to the success of a Data Warehouse initiative. As the respondent from the tertiary education institution put it:

> "Information must be available on demand."

One of the strengths of a Data Warehouse is that, with the right front-end tools, it can provide senior executives with timely access to key corporate data, without having to wait for IS/IT to process a request to extract data. The more proficient the end user the more powerful the data access and analysis front-end tools can be. Seventeen percent of the respondents mentioned that the appropriate front-end tools should be provided to senior executives for accessing and displaying the information they need.

One bank currently does not provide its users with any facilities to access the data in the Data Warehouse themselves. It has a central IS/IT function that generates information from the Data Warehouse upon request from business users, and distributes it on paper. This undermines the inherent ability of a Data Warehouse to provide timely access to data, since the senior executives of the bank are only slightly better off than without the Data Warehouse. They still have to formally request information from the IS/IT department, with delays of up to three days before receiving a response. With such long cycles the decision process is broken, and it is difficult for a decision maker to establish and investigate trends and subtleties that are contained within the information.

Seventy two percent of the respondents stressed that it is critically important for business users and executives to be able to rely on and trust the data presented to them. According to one respondent from the mining industry:

> "People must not be able to question that it's the latest data, that it's there, that it's available."

Unless senior executives can rely on the data in a Data Warehouse they will revert back to those processes they have always used to obtain access to data, and will not use the Data Warehouse.

There should be formal 'audit' procedures in place to provide an opinion on whether the data in a Data Warehouse meets stipulated quality criteria such as accuracy, timeliness, and completeness. These procedures should focus on the reliability of the processes used to populate the Data Warehouse, rather than on the quality of specific data loads. For example, if the data loading process is reliable then the quality of data should be good. However, if the data loading process is unreliable, the quality of data may be good at one point in time, but there is no guarantee that it will be good after the next data load. The currency of data loads relative to the data in source systems may also make it difficult to give a reliable audit opinion on a specific data load. For example, since a data load is valid for a particular point in time, this data will differ from the data in an on-line source system that contains data that is changing on a daily or on an hourly basis.

Eleven percent of the respondents stressed the importance of testing the quality of the data in the Data Warehouse, while six percent of the respondents raised the need for a formal audit process.

Part of the process of providing good quality data is admitting to 'unreliable' data. One respondent from the banking industry claimed that their Data Warehouse project has

gained significant credibility by monitoring the trends, changes and reconciliations of their data loads, and reporting these to the business. In this way the business knows how much reliance they can place on the data in the Data Warehouse, and can adjust its decisions accordingly.

Part of the process of ensuring that a Data Warehouse contains good quality data is the implementation of proper 'housekeeping' practices. These are the various processes and procedures needed to ensure that only good quality data is fed into the Data Warehouse from source systems. The need for proper 'housekeeping' practices was mentioned by twenty two percent of the respondents.

A Data Warehouse initiative is often driven by a need to bring information together from a variety of disparate systems to allow an enterprise-wide, integrated view of a specific subject area, such as customers or products. Thirty three percent of the respondents discussed the need for a consolidated, integrated view of critical business information. As one respondent from the banking industry put it:

> "... we needed to bring all the information from our little cottage systems together so that we could get a total view of one customer."

Similarly, according to the respondent from the medical aid administration industry:

> "...the advantage of the Data Warehouse to our executives is that it provides a comprehensive picture of what is happening in health care environments across the country."

Thirty nine percent of the respondents specifically mentioned the importance of a 'single version of the truth' of critical business information. One respondent from the mining industry stressed the importance of having:

> "...one system that provides all of management's information requirements."

This 'single version of the truth' is important to ensure that the performance of the business is reported in a consistent manner. One of the problems of having different figures from different systems for the reporting of business performance, is that often the validity of the figures becomes the central debate, rather than the significance of the figures themselves. It can happen that poor performance in specific areas of an organisation, or by specific individuals, can be hidden by the inconsistent manner in which information is reported from different systems.

Six percent of the respondents stressed the importance of populating the Data Warehouse with the appropriate level of detail of data. There is a delicate balance between the level of detail that should be stored, the needs of the business, and the cost of storing the data. If all data is stored at the lowest level of detail users may only access small subsets of it. Furthermore, the greater the level of detail the higher the cost of the infrastructure

needed, and the lower the potential ROI. However, if data is not stored at the lowest level of detail there is a risk that the ability of the business to perform analysis will be constrained, and important business opportunities or threats may be hidden. Furthermore, as business users become more comfortable with accessing the Data Warehouse their requirement to analyse lower levels of detail may increase. Ultimately, the level of detail that is to be stored should be based on the value that is likely to be derived from the detail.

A sound infrastructure of networks, and operational and tactical information systems, such as SAP R/3 and Electronic Point Of Sale Systems, form the supporting backbone of a Data Warehouse. This infrastructure, as pointed out by thirty three percent of the respondents, is critical for ensuring that good quality data is supplied to, and accessible from the Data Warehouse. It is very difficult to provide good quality data when the supporting infrastructure is inadequate and the source systems that feed the Data Warehouse are providing poor quality data. If, however, good quality data is not available from source systems this should not necessarily preclude the development of a Data Warehouse, provided users are made aware of the problems with the quality of the data, and where these problems originate. If source systems are providing poor quality data to the Data Warehouse they will also be providing poor quality data to the rest of the business. The danger of implementing a Data Warehouse in an environment where the source systems are supplying poor quality data is that the Data Warehouse could be seen as the mechanism for solving all data quality problems, both strategic and operational. This was illustrated by one respondent from the retail industry who claimed that his organisation was deliberately using its Data Warehouse as an Operational Data Store in an attempt to make up for the lack of easily accessible operational data from its legacy Transaction Processing Systems. This respondent pointed out that:

> "When the Data Warehouse came about the first thing the business wanted was the lowest level of operational information. We are still doing a lot of this type of work rather than focusing on the EIS type of work."

Six percent of the respondents mentioned the importance and value of having historical data in the Data Warehouse. Historical data is valuable because it allows users to perform trend and comparative analysis, and allows users to:

- Understand cause and effect relationships between business variables;
- Analyse production and sales patterns of products;
- Monitor the effects of improvement initiatives; and
- Understand the behavioural patterns of customers.

Twenty two percent of the respondents mentioned the importance of having a single repository of business metadata that is readily available to end users. A repository of business metadata is where the common, agreed definitions of each of the data elements in a Data Warehouse, is kept. Furthermore, the metadata should also identify the owner of each data element, its source system/s, and how it is derived, so that data quality problems can be addressed at their source. Metadata is critical to ensure that end users

can interpret the results they obtain from the Data Warehouse. According to one respondent from the banking indust.

> "In a Warehouse the metadata is your one means of telling your business users what is in the Warehouse. It is important to have a specific and unambiguous description of your data that is rigorous without being too good. If you don't have metadata then you don't have agreement on what the Warehouse means to different people."

For the metadata to contain agreed definitions of each data element it is important that each data element is defined through consensus, not only of the naming conventions, but also of how the data element is made up and how it is derived. Also, it is important that the metadata is easily maintained, as the task of keeping it current and accurate can become onerous and very time consuming.

None of the respondents mentioned the need to include external information in their Data Warehouses. This may be due to one, or all, of the following factors:

- The lack of reliable sources of relevant external information;
- The availability of large volumes of data from the Internet;
- The required external data or information may be in from that is inappropriate for inclusion in a Data Warehouse. For example, video clips, voice messages, or rumours that are entered as free form text;
- A lack of awareness of what external data is available;
- A lack of clarity amongst senior executives regarding what external information they need; and
- The use of an internally focused information gathering approach.

4.6.10 User participation

Sixty one percent of the respondents mentioned the importance of actively involving end users, not only in the development, implementation and testing of a Data Warehouse, but also in selecting the front-end tools and defining the system objectives and information requirements. As the respondent from the IT services industry put it:

> "...you should involve users in every single non-technical decision that there is to make."

If users are adequately involved throughout the project their expectations should automatically be managed, and they should also be fully aware of the value and usefulness of the Data Warehouse. Active user participation should create a common vision, both within the business and within the project team, of the scope and objectives of the project. For these reasons seventeen percent of the respondents felt that there is a reciprocal relationship between user participation and user expectations. As one respondent from the IT services industry remarked:

"If you have continuous user involvement you can control expectations."

According to another respondent from the retail industry:

> "By involving the users throughout the development cycle they [the users] were seeing what it is going to look like, what it can do, and what it can't do; so there was no big surprise at the end when we gave it to them. They knew exactly what is was going to look like because they had built it."

Eleven percent of the respondents suggested that an effective mechanism for ensuring active participation at all levels is a steering committee. However, in addition to the disadvantages of a steering committee discussed in section 4.6.4, there are other problems associated with relying on a steering committee as the *only* mechanism to achieve user participation. If it is the only mechanism, there may be a temptation to include as many stakeholders on the steering committee as possible. A steering committee should not be allowed to become too large for the following reasons:

- The decision cycles may become too long;
- There may be too many conflicting interests to accommodate;
- There may be a loss of focus on core issues;
- It may be difficult to coordinate the attendance of all members; and
- Meetings may become long and ineffective.

Furthermore, it may not be practical to have a steering committee comprised of staff from all levels within the organisation.

Eleven percent of the respondents stressed the importance of carefully selecting the end users that should be involved in the project. To ensure that the project achieves it objectives the following types of users should be chosen:

- Those who are willing and able to devote a substantial amount of time to the project;
- Those who are enthusiastic to help realise meaningful results;
- Those who can offer constructive criticism and are aligned with what the project aims to deliver;
- Those who can effectively articulate the business needs;
- Those who can make, or have key business decisions made quickly; and
- Those who will communicate progress throughout the organisation.

One of the respondents from the banking industry mentioned that the mechanism they use to ensure user participation is to appoint a full-time Data Warehouse specialist in each business unit. These specialists supervise the work the Data Warehouse is doing for their particular business unit.

Involving end users in a Data Warehouse initiative can have significant benefits for the project, but should be managed carefully. It is not practical or desirable to include all affected stakeholders, because accommodating all of their needs will make the project unmanageable. Only those users that will add value and will help achieve acceptance of the Data Warehouse, should be chosen.

4.6.11 Education, training, and support

Seventy two percent of the respondents stressed the importance of educating and training end users. Education and training should not only cover the use of the various Data Warehousing front-end tools, but should also cover what data is available, how to access and extract it, and what to do with it. This will not only empower users to extract and analyse data themselves, but will also give them the confidence to do it on their own. As one respondent from the IT product sales and support industry put it:

> "...if you want to make sure that managers aren't daunted they must be trained."

According to another respondent from the mining industry:

> "...the business expertise needs to be made aware of the power of the tool and how to use it."

Training should also create a more general awareness of what technology can do for the business and how various technologies relate to each other. For example, one respondent mentioned that his organisation had developed training and awareness programs that deal with Windows 95, spreadsheet usage, SAP R/3, and the front-end tools associated with their Data Warehouse.

Seventeen percent of the respondents stressed the importance of correctly timing the training. As the respondent from the telecommunications industry put it:

> "Training must be done at just the right time. Train people too long before and they lose interest before they can use it, and you can't really roll out if you haven't trained."

Twenty two percent of the respondents mentioned the need for adequate support personnel who are always available to assist end users. Twenty two percent of the respondents also suggested that part of the education process was the need for a form of 'hand-holding', especially of executive users. One of the respondents from the mining industry suggested that an appropriate way of doing this is to employ a number of expert Information Specialists who understand information, and who understand business. These Information Specialists can guide senior executives in the use of the front-end tools, as well as the data in the Data Warehouse. The role of these Information Specialists is to create an awareness, communicate, and empower business users to effectively use the Data Warehouse front-end tools. There is a risk that executives can come to rely on these Information Specialists, and that it will be difficult to phase them out after a while.

Seventeen percent of the respondents mentioned that education and training of end users is an ongoing, repetitive process, rather than an event. This is because there are always new users wanting to gain access to the data in a Data Warehouse, new data being loaded

into a Data Warehouse, and new and improved software being introduced. The need for ongoing, repetitive training can be dealt with in a number of ways. In the absence of sufficient capacity within an organisation, use can be made of external independent training facilities. However, the disadvantages of this approach are numerous:

- Training courses can be superficial;
- Users may not be trained using 'real' data from their organisation, or even from their own industry. This can leave them feeling uncomfortable with their ability to use the software in their own environment; and
- Examples used can be superficial or specifically tailored to highlight the strengths, and not the weaknesses, of the software tools and the Data Warehouse.

Alternatively, a 'train the trainer' approach can be used where designated, competent individuals from the business are trained in the use of the various software tools. These individuals then develop training courses based on the organisation's data, and using relevant examples. An important advantage of this approach is that a trainer is theoretically always available on-site to deal with specific training issues. Six percent of the respondents mentioned that their organisations had an in-house training capability. One of the respondents had received extensive training on the front-end tool used by their organisation and is now responsible for training newcomers and for doing 'refresher' courses.

Twenty two percent of the respondents felt that today's executive is not adequately computer literate, and in some cases is afraid of technology. According to one respondent from the banking industry this situation stems from the fact that many executives have not grown up with personal computers and do not really know how to use them. The respondent claimed that this represents a significant barrier to the acceptance and ultimate success of a Data Warehouse initiative. All twenty two percent of these respondents believed that this 'generation gap' is likely to fall away as younger managers, who are more comfortable with using technology in their jobs, work their way into executive positions. There were two diametrically opposed views regarding whether executives should be trained to use software front-end tools to access the data in a Data Warehouse themselves. Six percent of the respondents felt that it was necessary and that the front-end tools are available and are sufficiently easy to use. Another six percent, however, felt that executives should not be forced to use Data Warehouse front-end tools. These respondents felt that alternative ways should be sought to make any useful data that resides in a Data Warehouse available to executives as and when they need it. One way of addressing the fear of existing executives is to make them aware of the potential value of the technology, specifically in terms of the information that can be provided to them for improved decision making. Ultimately, the decision as to whether senior executives should be trained to use front-end tools should be made by the executives themselves. The decision should only be made once the executives have been given adequate opportunity to see the value of the data in the Data Warehouse, and the use of the front-end tools to access this data.

Eleven percent of the respondents stressed the importance of not only training end users, but also IS/IT staff. This will enable IS/IT staff to effectively and efficiently implement

and maintain the hardware, software and front-end tools associated with a Data Warehouse. Although Data Warehousing is not a new concept, the technology and techniques surrounding it are fairly unique, such as the complexity of data modelling for a decision support environment. Furthermore, these technologies and techniques have advanced rapidly over the last few years.

The respondents mentioned three approaches that can be used to train IS/IT staff. The first approach, mentioned by six percent of the respondents, is where vendors or independent training institutions present formal training.

The second, mentioned by eleven percent of the respondents, involves adopting a philosophy of 'learning by doing' Technical staff are provided with minimal training and develop their Data Warehousing skills through practical 'hands on' experience. Although eleven percent of the respondents strongly advocated the 'learning by doing' approach, all these respondents were from the same bank. Therefore, their view may be the result of a perceived need to defend the approach adopted by the bank, rather than from a sincere belief that it is the most appropriate approach.

The third approach, mentioned by six percent of the respondents, is where the training of IS/IT staff is done through a process of 'knowledge transfer'. In this approach technical staff work with experienced practitioners to learn the required skills and techniques. However, the respondents expressed a concern at the lack of such experienced Data Warehousing practitioners, especially in South Africa. As a result of the lack of local experienced consultants, use is often made of international consultants with a view to learning from them. Unfortunately, when an iterative, prototyping approach is used to implement a Data Warehouse there is often not enough time for thorough knowledge transfer to take place, especially if the consultants are only involved in implementing one or two of the prototypes. It is also often not possible to retain the services of a good consultant for more than a few months due to the demand for their services.

One way of reducing the training burden is to select a front-end tool that users are already familiar with. Six percent of the respondents mentioned that one of the criteria for selecting their data analysis front-end tool was that users were already familiar it. This approach will, however, only apply to situations in which users have already had some exposure to data access and analysis front-end tools. This is why seventeen percent of the respondents mentioned that they had, or were in the process of choosing Internet technology to provide users access to their Data Warehouse, not only because it is easy to use, but also because most users' familiarity with the technology and its interface reduces the training burden significantly.

Eleven percent of the respondents stressed that training and education creates awareness. When business users are aware, not only of the value of a Data Warehouse but also of its limitations, their expectations will be more realistic. Therefore, there is a reciprocal relationship between education and training, and end user expectations.

Ongoing education, training and support is no less important in a Data Warehouse environment than what it is for any other IS/IT project. However, since a Data Warehouse is designed to improve the effectiveness of decision making, rather than the efficiency of business processes, it has an additional challenge associated with it. This challenge is making senior executives not only aware of the value of the data in the Data Warehouse, but also encouraging them to access and use this data themselves.

4.6.12 Flexibility of the Data Warehouse

Eleven percent of the respondents raised the importance of ensuring that the technical solution caters for the ongoing addition of data to meet the information requirements dictated by long term business needs. The scalability of the technical solution chosen is critical for a number of reasons:

- The more a Data Warehouse is used, and as its user base increases, the greater the need for additional data, and the more the Data Warehouse must be able to grow; and
- One of the factors that differentiates a Data Warehouse from a Transaction Processing System is that historical data is stored that allows trends to be followed and comparisons to be made over time. Therefore, to be able to store more historical data the Data Warehouse must be able to grow.

Twenty two percent of respondents raised the importance of having a thoroughly planned and well designed data architecture. A poorly designed data architecture will limit future flexibility in terms of system scalability and data analysis capability, and is likely to reduce potential ROI. The data should be stored at the lowest possible level of detail, within given practical and cost constraints, to allow the business maximum flexibility to do analysis. When data is stored at the lowest level of detail it is easy to summarise it for specific views, but it is not possible to drill down into a level of detail lower than that which has been stored in the Data Warehouse. However, storing data at the lowest level of detail also increases the volume of data significantly and this in turn increases the demands on the Data Warehouse to efficiently store and retrieve the data. The factor that complicates the data architecture of a Data Warehouse and differentiates it from the data architecture of an operational system is the time dimension. Each data element stored in a Data Warehouse is time stamped after which it is not changed or removed. This allows a history of the data element to be built up over time. Even if the data architecture is well designed it may still have to be enhanced, or even rearchitected over time to respond to changes in the business and its information requirements. As one respondent from the banking industry put it:

> "Everyone says that the dimensions of the Data Warehouse are so stable. What can change? Customer, products, geography, time - nothing can change there - Wrong! Our customer is already a different model from the customer that we started the Data Warehouse with."

Eleven percent of the respondents admitted that their organisations had to reconstruct their Data Warehouses a number of times as a result of poorly designed data

architectures. For example, one of the respondents from the banking industry regarded the storing of summarised data in their Data Warehouse as a setback because when the time came to analyse their data at transaction level it was not possible, because their data had not been stored at this level. The bank then had to re-design and re-implement its Data Warehouse so that it contained transaction level data.

Fifty five percent of the respondents pointed out that different users have different information, analysis, and presentation requirements. Some users require highly aggregated data that does not always need to be up-to-date, while others need very accurate, up-to-the-minute information. Each type of user may prefer different report formats and layouts and different methods of data analysis. Various users may require different levels of analysis sophistication and complexity. For example, executive users seldom require sophisticated analysis functionality; middle managers and technical staff often require the capability to do complex, in-depth analysis; and well trained, highly skilled technical staff may need to do Data Mining. The Data Warehouse and its associated front-end tools should be flexible enough to accommodate such a wide variety of needs and preferences. This often points to the need to provide different front-end tools to different users. As the respondent from the tertiary education industry put it:

> "It is critical that users are allowed to have the tools they can best work with."

Twenty two percent of the respondents felt that data access front-end tools based on Internet technology are a good solution for providing inexpensive, flexible access to the data in a Data Warehouse environment. These front-end tools contain user defined dynamic reports, with various analysis capabilities including 'drill down' and 'drill across' functionality. Furthermore, these front-end tools allow the user base to be increased substantially in a very short period of time with minimal, if any, disruption to the business. One of the reasons for the scalability and ease of implementation of data access and analysis front-end tools based on Internet technology is that no sophisticated software is required on client Personal Computers. One respondent from the retail industry claimed that:

> "You can go from one hundred to five hundred users in a day if you had to because it's totally scalable."

Although respondents did mention the importance of the flexibility of a Data Warehouse and its associated front-end tools it was generally regarded as more of a technical issue. With the appropriate technical skills and competencies and the correct choice of technical infrastructure, flexibility is of lesser importance than the 'softer' issues such as senior management commitment, information quality, and demonstrated value.

4.6.13 Ease of use

Many of the front-end tools associated with Data Warehousing provide a variety of features such as an EIS interface, 'slice and dice' capabilities, drill down functionality, reporting features, and graphical, tabular as well as textual interfaces. However, the respondents seldom mentioned the need for specific features and the key criterion cited for the acceptance of a specific front-end tool was its ease of use. Seventy eight percent of the respondents specifically stressed the importance of providing easy access to data in the Data Warehouse. In general, it was felt that ease of use directly affects the usage of a specific front-end tool.

Ease of use does not only apply to the front-end tools used to access and analyse the data in a Data Warehouse. Six percent of the respondents stressed that it also applies to the software tools used to provide access to business metadata.

Various users may require different levels of analysis sophistication and complexity. In general, the more complex a front-end tool the more difficult it will be to use. Therefore, as seventeen percent of the respondents pointed out, different levels of functionality and ease of use should be provided to different types of users. One respondent from the retail industry claimed that the level of computer literacy of a user should not be used as an excuse for not giving them an appropriate front-end tool to gain access to the data in a Data Warehouse. As this respondent put it:

> "At each level as long as you provide them [users] with the right tools and the right technology they will be fine."

Twenty eight percent of the respondents suggested that Internet technology is an effective, easy to use solution for providing data access to a wide variety of users in a very short period of time. One respondent from the banking industry felt that the use of Internet technology may encourage executives who are not comfortable with technology to access the data in a Data Warehouse.

The targeted user population should dictate how easy a front-end tool must be to use. Specifically, executive users seldom require sophisticated analysis functionality and are unlikely to access the Data Warehouse every day. Furthermore, executives often prefer graphs to tables and text so that they can see trends, patterns, variances and abnormal situations at a glance. Therefore, the front-end tools provided to them must be graphical and so easy to use that they are intuitive, and require little or no training.

4.7 Conclusion

The preceding analysis and discussion of the research evidence focused at a detailed level on the issues raised by the respondents. Although the issues raised were discussed as logical groupings of themes there is a strong overlap between logical groupings, and the following relationships are evident:

- The approach to establishing the system objectives and business information requirements is not necessarily independent of the approach used to implement a Data Warehouse. For example, in a prototyping approach the development of a prototype takes place in parallel to, and as a means to establish the business information requirements;
- There is a link between the commitment of senior executives to a Data Warehouse initiative and its value;
- There is a link between user expectations and user participation;
- There is a link between political and cultural issues, and senior management commitment;
- There is a link between the commitment of senior executives to a Data Warehouse initiative and the quality of data that resides in it; and
- There is a link between user expectations, and education and training.

Each logical grouping in section 4.6 relates directly to the empirical generalisations proposed for this research. Furthermore, each empirical generalisation represents a proposed CSF for implementing an EIS based on a Data Warehouse. The strong relationships between the logical groupings indicate that the empirical generalisations need to be revised to be more useful.

Chapter five takes a broader view of the content analysis by relating it, at a higher level, to the empirical generalisations to establish the level of support for the empirical generalisations. Chapter five also reviews the research results against the aim and objectives of this research.

CHAPTER FIVE: CONFIRMATION AND REFINEMENT OF THE RESEARCH

5.1 Introduction

Chapter five reviews the research results against the aim and objectives of this research, as presented in chapter one, and against the theoretical conjecture and empirical generalisations presented in chapter two. The objectives of this chapter are to determine the extent to which the aim and objectives of the research have been achieved, and the level of support for the empirical generalisations. Based on the support for the empirical generalisation a refined theoretical conjecture is proposed.

The first step of the research process was an extensive literature review to assess established theoretical frameworks. This, together with the research problem, was used to postulate the theoretical conjecture, from which the empirical generalisations were developed. The next section presents the rationale for establishing the level of support for the empirical generalisations. The section after it discusses the extent to which the research evidence supports the empirical generalisations.

5.2 Content Analysis

5.2.1 Link to chapter four

This chapter takes the discussion in section 4.6 further by using it to establish the level of support for the empirical generalisations. The content analysis presented in section 4.4 in chapter four is presented at a higher level of abstraction in table 5.1. Only that part of the analysis that pertains to establishing the level of support for the empirical generalisations is presented here. Furthermore, although more than one theme supports each empirical generalisation as shown in table 4.2, these themes have been omitted from table 5.1.

Table 5.1 shows the empirical generalisations that were proposed in sections 2.5 and 3.4, in the left hand column, numbered from one to thirteen. For the sake of clarity, the mapping that indicates which number corresponds to which empirical generalisation is presented in table 5.2.

Table 5.1 also shows the number of respondents that mentioned that a particular empirical generalisation was critical, the *total* number of times the empirical generalisation was mentioned, and the *average* number of times the empirical generalisation was mentioned. Although rankings have been shown they *do not* represent the importance of each empirical generalisation relative to each other. This is because each empirical generalisation represents a Critical Success Factor (CSF) and, by definition, each and every CSF *is critical* on its own and, if not achieved, will result in failure. The rankings indicate the level of support for each empirical generalisation and

are intended to help provide clarity on the meaning of the results of the content analysis, from different perspectives. Furthermore, the rankings are intended to highlight potentially significant findings that would not be immediately obvious if the results were to be viewed from a single perspective.

Table 5.1 Summary of the content analysis used to establish the level of support for the empirical generalisations

EG*	No. of respondents who mentioned an issue	% of total no. of respondents	Ranking	Total times an issue was mentioned	Ranking	Ave no of times mentioned per respondent**	Ranking
1	18	100.00	1	155	4	8.61	6
2	17	94.44	2	125	7	7.35	8
3	15	83.33	3	146	5	9.73	4
4	17	94.44	2	300	2	17.65	1
5	12	66.67	5	103	8	8.58	7
6	14	77.78	4	128	6	9.14	5
7	9	50.00	7	48	12	5.33	11
8	18	100.00	1	286	3	15.89	3
9	18	100.00	1	306	1	17.00	2
10	11	61.11	6	60	10	5.45	10
11	17	94.44	2	125	7	7.35	8
12	12	66.67	5	54	11	4.50	12
13	14	77.78	4	83	9	5.93	9

* EG = Empirical Generalisation

** The average was taken over the number of respondents who mentioned the issue as critical, not over the total number of respondents interviewed.

Table 5.2 Numerical values corresponding to each empirical generalisation

EG	Description
1	There must be a clear link between the data / information provided by an Executive Information System (EIS) based on a Data Warehouse and the goals and performance measures of the business
2	An approach, which is best suited to the specific circumstances of the business, should be used to establish the system objectives and business information requirements of an EIS based on a Data Warehouse
3	An iterative, prototyping approach must be used to implement an EIS based on a Data Warehouse
4	There must be active, demonstrated support and commitment from both executives and the project team when implementing an EIS based on a Data Warehouse
5	The expectations of the end users of an EIS based on a Data Warehouse must be managed
6	The political and cultural issues surrounding the implementation of an EIS based on a Data Warehouse must be managed

EG	Description
7	The issue of the security of data and information must be resolved when implementing an EIS based on a Data Warehouse
8	There must be demonstrated value and benefit to the business when implementing an EIS based on a Data Warehouse
9	An EIS based on a Data Warehouse must provide good quality external and internal information to end users
10	There must be active participation by end users when an EIS based on a Data Warehouse is implemented
11	End users must be provided with adequate education and training when implementing an EIS based on a Data Warehouse
12	The EIS and Data Warehouse must be flexible enough to be tailored to the specific needs of executive users, and to be changed in response to changes in the user base and their information requirements
13	An EIS based on a Data Warehouse must be easy to use

The values listed in table 5.1 are presented graphically in figures 5.1, 5.2, 5.3, and 5.4. Figures 5.1, 5.2, 5.3, and 5.4 show the different perspectives used to understand the results of the content analysis.

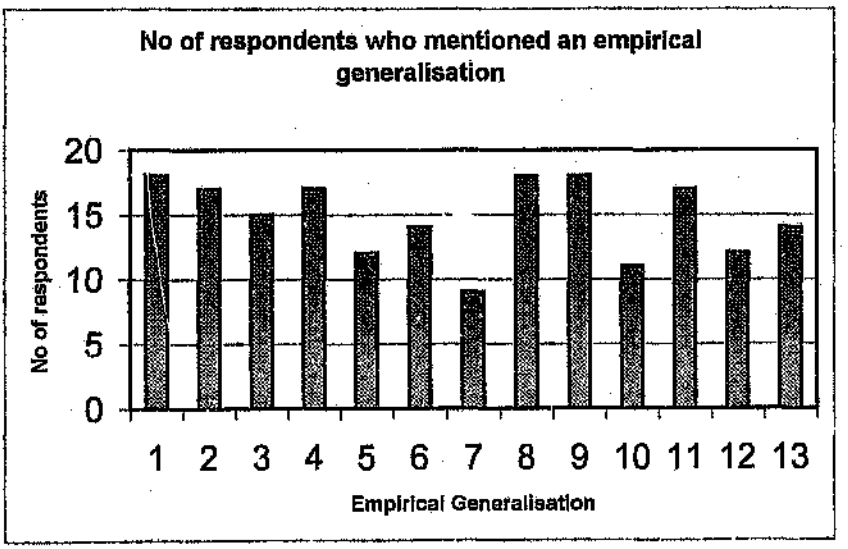


Figure 5.1 The number of respondents who mentioned an empirical generalisation

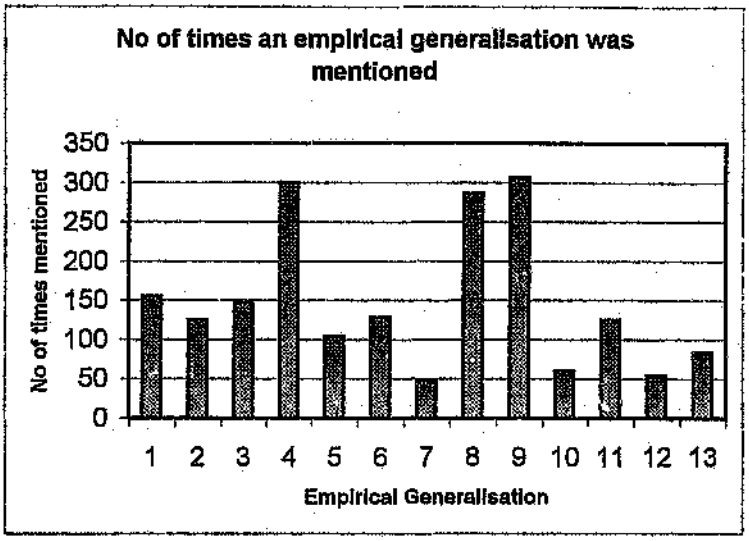


Figure 5.2 The total number of times each empirical generalisation was mentioned

To allow a broader perspective to be taken on the extent to which an empirical generalisation is supported, it is necessary to look at both how many respondents mentioned an issue *and* how often it was mentioned. For example, a particular issue may have been regarded as critical by all respondents, such as the first, eighth, and ninth empirical generalisations in figure 5.1. However, viewing the results from this perspective only is not enough. Figure 5.2 illustrates that even though the first empirical generalisation was mentioned by all of the respondents, the fourth empirical generalisation was mentioned more often, even though it was not mentioned by all of the respondents. A combined view is illustrated in figure 5.3. In figure 5.3 it can be seen that, in general, when a respondent felt that an issue was critical, they tended to raise it often. For example, if they felt that the ninth empirical generalisation (the provision of good quality external and internal information to end users) was important they would mention it repeatedly, often using examples to illustrate their point.

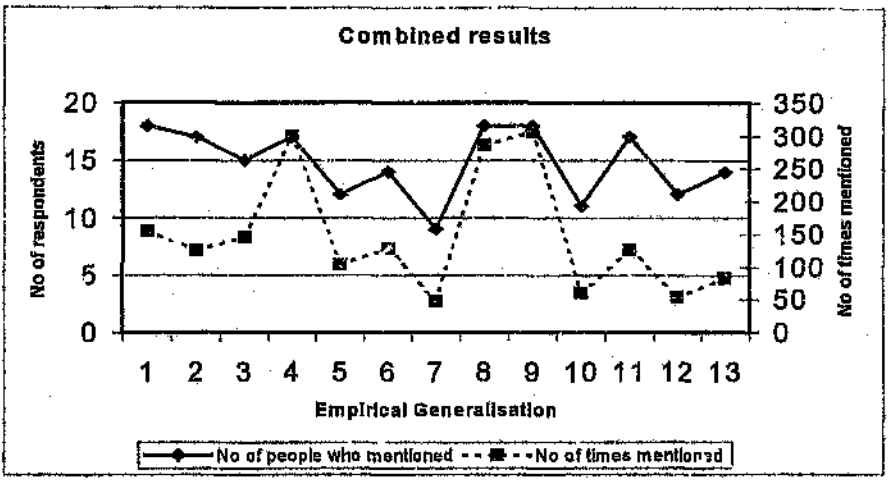


Figure 5.3 The number of respondents who mentioned an empirical generalisation compared to the total number of times it was mentioned

To better understand how important each respondent felt a particular empirical generalisation was, the total number of times an empirical generalisation was mentioned was divided by the number of respondents that mentioned the empirical generalisation. The total number of times an empirical generalisation was mentioned was *not* divided by the total number of all respondents, as this would give a false impression of how important the respondents felt an empirical generalisation was. The results are shown in table 5.1, as well as in figure 5.4.

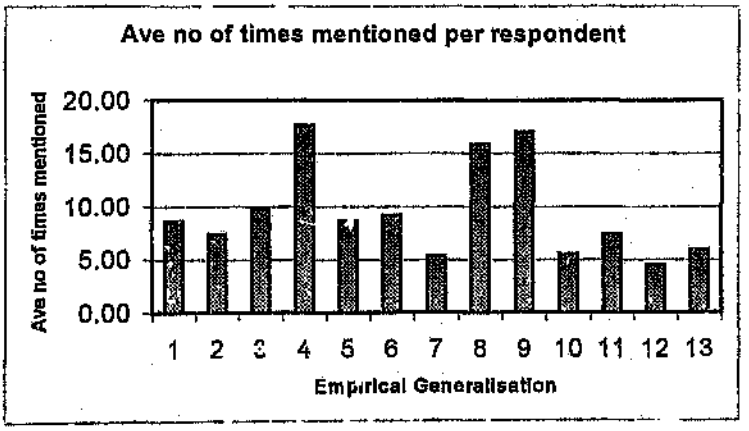


Figure 5.4 The average number of times an empirical generalisation was mentioned by the respondents who mentioned it

5.2.2 Establishing the levels of support

To define the level of support for a particular empirical generalisation three somewhat arbitrary 'levels' were selected: Strongly Supported, Moderately Supported, and Poorly Supported.

To establish what 'level' an empirical generalisation falls into, the highest average value for an empirical generalisation was selected from table 5.1 (17.65 for the fourth empirical generalisation). This value was divided by three to represent each 'level', as shown below:

- **Poorly supported** = an average value of less than or equal to 17.65 / 3 = 5.88;
- **Moderately supported** = an average value of more than 5.88 but less than or equal to 11.77; and
- **Strongly supported** = an average value greater than 11.77.

The numeric values separating each level were then used *as a guide* to establish the level of support for each empirical generalisation.

5.3 Review of the Empirical Generalisations

Throughout the discussion that follows, where reference is made to a Data Warehouse or to Data Warehousing, it implicitly refers to the executive information component of Data Warehousing.

5.3.1 First empirical generalisation

> There must be a clear link between the data / information provided by an EIS based on a Data Warehouse and the goals and performance measures of the business.

The importance of a clear link between the data / information provided by a Data Warehouse and the goals of the business was stressed by all of the respondents. It was mentioned a total of 155 times by all of the respondents, which represents an average of 8.61 times per respondent. From table 5.1 it can be seen that although this issue was mentioned by all of the respondents as critical, the number of times it was mentioned was only fourth highest, whilst the average number of times it was mentioned, per respondent, was only sixth highest.

Based on its average value, there is *moderate* support for this empirical generalisation. This is lower than expected especially since all the respondents mentioned the importance of the link between the data in a Data Warehouse, and the goals and performance measures of the business. However, as the respondents did not mention this empirical generalisation often, they may not have fully appreciated its significance. This lack of appreciation may be one of the primary reasons for the relatively low number of successful Data Warehouse implementations reported by the respondents (as shown in

section 4.5.3 only fifty percent of the respondents regarded their Data Warehouses as a success)

Most of the respondents stressed the importance of identifying the information that supports the goals and performance measures of the business, but did not specifically discuss the goals and performance measures themselves. These goals and performance measures must be clear, well defined, and senior executives must be committed to their achievement, to the extent that they are built into, and entrenched in the measurement systems of the organisation. Without this clarity, the data in the Data Warehouse may, at best, loosely allude to these goals and performance measures. Without commitment to the achievement of the business goals and performance measures, there will be no incentive for the executives, or their subordinates, to use the data in the Data Warehouse. The result is that there is an increased risk that the Data Warehouse initiative will fail.

The unexpectedly low level of support for this empirical generalisation may be the result of the management style that currently prevails in the respondents' organisations. When the data in a Data Warehouse is directly linked to well defined, meaningful strategic goals that are actively pursued by the most senior executives in an organisation, it is expected that there will be a better appreciation, and a correspondingly stronger support for this empirical generalisation.

5.3.2 Second empirical generalisation

> An approach, which is best suited to the specific circumstances of the business, should be used to establish the system objectives and business information requirements of an EIS based on a Data Warehouse.

The approach for establishing the system objectives and business information requirements was mentioned as critical by ninety four percent of the respondents. It was mentioned a total of 125 times by all of the respondents, which represents an average of 7.35 times per respondent. From table 5.1 it can be seen that the number of times it was mentioned was seventh highest whilst the average number of times it was mentioned, per respondent, was eighth highest.

Based on its average value this empirical generalisation is *moderately* supported. On the one hand this is surprising, since, in an unstructured decision environment such as that of a senior executive, the approach needed to establish the system objectives and business information requirements often depends on the personalities, management styles, and culture within an organisation. These can vary significantly from organisation to organisation. Under such circumstances it is likely that a number of different approaches, and combinations of approaches, should be followed to understand the decision environment and supporting information needs.

On the other hand, the moderate support for this empirical generalisation is not too surprising considering that often Data Warehousing projects are led by independent

consultants. Consultants frequently sell their services based on a promise to use 'world best practice' methodologies that are tailored to the specific needs of each organisation. In such cases the leadership, management and application of the methodology are left to the consultants and become of lesser importance to the remainder of the project team. An inexperienced project team is also often not in a position to question the validity of the manner in which consultant-led methodologies are applied. Unfortunately, despite promises of vast experience and tailor made, best practice methodologies, the failure rate of Data Warehouse projects remains high.

Twenty eight percent of the respondents felt that Data Warehousing as concept is still maturing (Section 4.5.2). In an environment that is evolving rapidly, it is conceivable that there will be many approaches for establishing the system objectives and business information requirements. However, few of these approaches will be well embedded, or generally accepted. The high failure rate of Data Warehousing projects is a clear indication that well defined, robust approaches have yet to emerge. Since the success of a Data Warehouse depends on the data stored in it, how well this data relates to the issues faced by the business in general, and the senior executives in particular, is of paramount importance. Therefore, the approach to understanding the data is itself critical. The application of an approach should depend on the specific circumstances, personalities, and culture that prevail in an organisation. As time passes and Data Warehousing matures, so will its associated approaches and methodologies, and there should, therefore, be stronger support for this empirical generalisation.

5.3.3 Third empirical generalisation

> An iterative, prototyping approach must be used to implement an EIS based on a Data Warehouse.

The approach to implementing an EIS based on a Data Warehouse was mentioned as critical by eighty three percent of the respondents. It was mentioned a total of 146 times by all of the respondents, which represents an average of 9.73 times per respondent. From table 5.1 it can be seen that the number of times it was mentioned was fifth highest, whilst the average number of times it was mentioned, per respondent, was fourth highest.

Although the importance of the approach to implementing a Data Warehouse was mentioned by eighty three percent of the respondents, the need for an iterative, prototyping approach was only mentioned by fifty percent of the respondents (Section 4.6.3). Those respondents that stressed the importance of adopting an iterative, prototyping approach did, however, mention it often. There is, therefore, *moderate* support for this empirical generalisation.

A 'big bang' approach was endorsed by eleven percent of the respondents (Section 4.6.3). Those respondents that endorsed the 'big bang' approach did not mention it often. Furthermore, they were involved in Data Warehouse projects that either implemented a *limited* subset of data across the entire organisation, or implemented the data for a

complete subject area in *one* part of the business. Therefore, although these approaches may not have been iterative, and may not have involved prototypes, it is questionable whether they were in fact 'big bang' approaches.

It is surprising that there was not a stronger level of support for this empirical generalisation. There is strong support for the fourth and eighth empirical generalisations (Sections 5.3.4 and 5.3.8) which deal with senior management commitment and demonstrated value. Furthermore, thirty three percent of the respondents stressed that buy-in and subsequent continued business support depends on how much benefit can be demonstrated, and how soon this benefit can be shown (Section 4.6.8). A prototyping approach is well suited to obtaining appropriate end user involvement and demonstrating meaningful results in the short term, and in so doing encouraging the commitment of end users. Therefore, as the approaches to implementing Data Warehouses mature and Data Warehouse practitioners see the benefits of a prototyping approach, there should be stronger support for this empirical generalisation.

5.3.4 Fourth empirical generalisation

> There must be active, demonstrated support and commitment from both executives and the project team when implementing an EIS based on a Data Warehouse.

The importance of the support and commitment of both business executives and users, as well as of IS/IT was stressed by ninety four percent of the respondents. It was mentioned a total of 300 times by all of the respondents, which represents an average of 17.56 times per respondent. From table 5.1 it can be seen that this is the second highest number of times that an issue was mentioned, which translates into the highest average number of times that it was mentioned, per respondent.

Although this empirical generalisation was not mentioned by all of the respondents, those who did mention it mentioned it often, and for this reason there is *strong* support for it. The level of support for this empirical generalisation is not surprising since the issue of commitment is multi-dimensional and far reaching. The importance of commitment is reflected by the fact that fifty percent of the respondents stressed the need for business buy-in, and eighty three percent felt that the business should initiate, drive and own the Data Warehouse initiative (Section 4.6.4). Furthermore, thirty three percent of the respondents also felt that IS/IT resources should be committed to the project (Section 4.6.4). Without senior management commitment the following risks may materialise:

- The business will not initiate, drive or own the project;
- The business will not commit adequate time or resources to the project;
- The data in the Data Warehouse will not relate the goals, or the issues facing senior executives;
- There will be no incentive to ensure that good quality data is stored in the Data Warehouse;
- The Data Warehouse will not deliver any value;

- There will be no incentive for the business to use the Data Warehouse; and
- IS/IT staff will not be committed to the project.

The importance of commitment is further highlighted by the fact that twenty two percent of the respondents felt that there is a reciprocal relationship between the level of commitment by the business and the perceived value of the Data Warehouse initiative. It is significant, therefore, that the eighth empirical generalisation, which deals with the value of a Data Warehouse, is also strongly supported (Section 5.3.8).

5.3.5 Fifth empirical generalisation

> The expectations of the end users of an EIS based on a Data Warehouse must be managed.

The importance of managing the expectations of the end users was raised by sixty seven percent of the respondents. It was mentioned a total of 103 times by all of the respondents, which represents an average of 8.58 times per respondent. From table 5.1 it can be seen that the number of times this issue was mentioned as critical was eighth highest, whilst the average number of times it was mentioned, per respondent, was seventh highest.

Seventeen percent of the respondents felt that end user expectations could be effectively managed with the following mechanisms (Section 4.6.5):
- Active user involvement;
- Continuous communication and feedback; and
- Effective education and awareness programs.

These are all recognised change management techniques that should form part of a good project management approach. Seventeen percent of the respondents felt that there is a reciprocal relationship between user participation and involvement, and user expectations (Section 4.6.10), and eleven percent of the respondents felt that training and education creates awareness (Section 4.6.11), which will lead to more realistic expectations. Therefore, the *moderate* level of support for this empirical generalisation may stem from the fact that the respondents feel that with adequate project management, user participation and involvement, and effective training and education, the issue of user expectations falls away.

5.3.6 Sixth empirical generalisation

> The political and cultural issues surrounding the implementation of an EIS based on a Data Warehouse must be managed.

The importance of managing the political and cultural issues surrounding the implementation of an EIS based on a Data Warehouse was raised as critical by seventy

eight percent of the respondents. It was mentioned a total of 128 times by all of the respondents, which represents an average of 9.14 times per respondent. From table 5.1 it can be seen that the number of times this issue was raised as critical was sixth highest, whilst the average number of times it was mentioned, per respondent, was fifth highest.

Based on its average value there is *moderate* support for this empirical generalisation. Those respondents that raised political and cultural issues mentioned them in the context of technology and data ownership, the threat of losing control, the fear of losing political power, the lack of an information culture, an autocratic decision culture, the choice of technology, and the management of outsource partners.

The issue of technology and data ownership is relatively easily resolved through education and training programs. Furthermore, the choice of technology and the management of outsource partners is also relatively easily resolved through competent management. The remaining issues all relate to the management style and culture of the organisation, that extend far beyond the implementation of a Data Warehouse, but that directly affect its likelihood of success. These are not issues that can be resolved within an implementation project, unless there is strong commitment at the highest levels within the organisation, not only to the project, but also to the overall organisational changes required for it to succeed. A Data Warehouse will not succeed in an environment where the sharing of information is not actively encouraged and rewarded, and where political power is based on information that can be closely guarded by key individuals within an organisation. This is, therefore, inextricably linked to senior management commitment in its broadest sense.

5.3.7 Seventh empirical generalisation

> The issue of the security of data and information must be resolved when implementing an EIS based on a Data Warehouse.

The issue of addressing the security of data and information was raised as critical by fifty percent of the respondents. It was only mentioned a total of 48 times by all of the respondents, which represents an average of 5.33 times per respondent. From table 5.1 it can be seen that the number of times it was mentioned was only twelfth highest, whilst the average number of times it was mentioned, per respondent, was only eleventh highest.

This empirical generalisation is *poorly* supported. This may be due to the fact that the respondents may not have fully understood the issue. For example, they may have thought that it relates to the software and hardware mechanisms for controlling logical access to sensitive data, rather than to the philosophy that should be applied to the sharing of information. This is supported by the fact that only seventeen percent of the respondents believed that a Data Warehouse should be implemented with a philosophy of information sharing (Section 4.6.7). A Data Warehouse that is implemented in an environment where the sharing of information is not actively encouraged and rewarded will fail. This issue, therefore, relates strongly to the information culture within an

organisation, and the level of commitment of senior executives to establishing this culture.

5.3.8 Eighth empirical generalisation

> There must be demonstrated value and benefit to the business when implementing an EIS based on a Data Warehouse.

The importance of demonstrating value and benefit to the business was raised by all of the respondents. It was mentioned a total of 286 times by all of the respondents, which represents an average of 15.89 times per respondent. From table 5.1 it can be seen that the number of times it was mentioned was third highest, whilst the average number of times it was mentioned, per respondent, was also third highest.

This issue was mentioned by all of the respondents was mentioned often. Therefore, there is *strong* support for this empirical generali . This is not surprising since there will always be a strong link between the commitment of senior executives to an initiative, and the financial return they believe they will be receiving from it. Senior executives of commercial organisations are implicitly or explicitly measured on the value they add to the shareholders of the organisation. They will, therefore, always continue to seek ways of improving the bottom line. This is supported by the fact that although there are myriad intangible benefits associated with Data Warehousing, sixty one percent of the respondents stressed the importance of demonstrating financial return (Section 4.6.8).

5.3.9 Ninth empirical generalisation

> An EIS based on a Data Warehouse must provide good quality external and internal information to end users.

The provision of good quality information to end users was mentioned as critical by all of the respondents. It was mentioned a total of 306 times by all of the respondents, which represents an average of 17 times per respondent. From table 5.1 it can be seen that, in addition to being mentioned by all of the respondents as critical, the number of times it was mentioned was the highest, whilst the average number of times it was mentioned, per respondent, was second highest.

All respondents mentioned the importance of good quality information, and mentioned it often. Therefore, there is *strong* support for this empirical generalisation. Senior executives must feel comfortable that the data they are basing their decisions on has the required reliability, availability and confidentiality. If they have any doubts about the data they will not use it, and will revert back to their traditional mechanisms for gathering and interpreting the data they need. Furthermore, there will be no reason for them to continue to support, and commit to a Data Warehouse that does not meet their information requirements. The fact that seventy two percent of the respondents stressed

that it is critically important that senior executives can rely on, and trust the data presented to them (Section 4.6.9), supports this.

Surprisingly, not one respondent mentioned the importance of including external information in the Data Warehouse (Section 4.6.9). This may be due to one, or all, of the following factors:

- The lack of reliable sources of relevant external information;
- The availability of large volumes of data from the Internet;
- The required external data or information may be in from that is inappropriate for inclusion in a Data Warehouse. For example, video clips, voice messages, or rumours that are entered as free form text;
- A lack of awareness of what external data is available;
- A lack of clarity amongst senior executives regarding what external information they need; and
- The use of an internally focused information gathering approach.

5.3.10 Tenth empirical generalisation

> There must be active participation by end users when an EIS based on a Data Warehouse is implemented.

The importance of the active involvement of end users in the implementation of an EIS based on a Data Warehouse was mentioned by sixty one percent of the respondents. It was only mentioned a total of 60 times by the respondents, which represents an average of 5.45 times per respondent. From table 5.1 it can be seen that the number of times it was mentioned was only tenth highest, whilst the average number of times it was mentioned, per respondent, was also only tenth highest.

Based on its average value there is *poor* support for this empirical generalisation. As stated in section 5.3.5, user participation is a recognised change management technique that should form part of a good project management approach. Therefore, the respondents may feel that it should be adequately dealt with in a good project management approach. Furthermore, fifty percent of the respondents supported the need for an iterative, prototyping approach (Section 4.6.3), and implicit in such an approach is the active participation of end users in defining and refining their requirements. These respondents may, therefore, have felt that user participation was already dealt with and did not need to be raised again.

5.3.11 Eleventh empirical generalisation

> End users must be provided with adequate education and training when implementing an EIS based on a Data Warehouse.

The provision of adequate education and training was mentioned as important by ninety four percent of the respondents. It was mentioned a total of 125 times by all of the respondents, which only represents an average of 7.35 times per respondent. From table 5.1 it can be seen that the number of times it was mentioned was seventh highest, whilst the average number of times it was mentioned, per respondent, was eighth highest.

Based on its average value, this empirical generalisation is *moderately* supported. The level of support for this empirical generalisation is lower than expected for the following reasons:

- Twenty two percent of the respondents felt that today's executive is not adequately computer literate (Section 4.6.11), and effective, focused training and education is one way of addressing this problem;
- Seventeen percent of the respondents recognised that one of the ways of managing end user expectations is effective education and training (Section 4.6.5); and
- Twenty eight percent of the respondents felt that senior executives should be aware of the value of a Data Warehouse (Section 4.6.8). Furthermore, twenty two percent of the respondents felt that there is a reciprocal relationship between the level of commitment by the business and the perceived value of a Data Warehouse initiative (Section 4.6.4). Eleven percent of the respondents felt that training and education creates awareness (Section 4.6.11). Education and training can, therefore, be used to create the required awareness, which in turn can positively affect the level of commitment of senior executives.

As stated in section 5.3.5, education and training may be seen as a change management technique that forms part of a good project management approach. The respondents may, therefore, have felt that with adequate project management, the issue of training and education falls away, and this may explain the moderate level of support for this empirical generalisation.

5.3.12 Twelfth empirical generalisation

> The EIS and Data Warehouse must be flexible enough to be tailored to the specific needs of executive users, and to be changed in response to changes in the user base and their information requirements.

The need for a flexible EIS based on a Data Warehouse was mentioned as important by sixty seven percent of the respondents. It was only mentioned a total of 54 times by all of the respondents, which represents an average of 4.5 times per respondent. From table 5.1 it can be seen that the number of times it was mentioned was only eleventh highest, whilst the average number of times it was mentioned, per respondent, was only twelfth highest.

Based on its average value this empirical generalisation is *poorly* supported. This level of support may be an indication that the flexibility of a Data Warehouse is largely a technical issue that is relatively easily dealt with using sound design approaches, and the

use of appropriate hardware and software. Although twenty eight percent of the respondents felt that Data Warehousing is still maturing (Section 4.5.2), the availability of a wide variety of powerful front-end tools, some of which are based on Internet technology, makes this issue of minor concern.

5.3.13 Thirteenth empirical generalisation

An EIS based on a Data Warehouse must be easy to use.

The need for an easy to use EIS based on a Data Warehouse was mentioned as critical by seventy eight percent of the respondents. It was mentioned a total of 83 times by all of the respondents, which represents an average of 5.93 times per respondent. From table 5.1 it can be seen that the number of times it was mentioned was ninth highest, whilst the average number of times it was mentioned, per respondent, was ninth highest.

There are a wide variety of powerful, user friendly front-end tools available for viewing and analysing the data in a Data Warehouse. Many of these front-end tools are now based on Internet technology, which presents users with a familiar, easy to use interface. Therefore, ease of use is no longer a key differentiating factor between the various front-end tools. It is, therefore, not surprising that there is *moderate* support for this empirical generalisation. One reason why this empirical generalisation is not poorly supported is that, even with the availability of easy to use front-end tools, it can still be difficult to understand and use a poorly designed data structure in a Data Warehouse.

5.3.14 Summary of the level of support for the empirical generalisations

The research evidence indicates that the respondents, to some extent, supported all of the empirical generalisations. However, the empirical generalisations need to be refined to be more useful, for the following reasons:

- There is varying support for each empirical generalisation; and
- There are interdependencies between the empirical generalisations. Each empirical generalisation represents a proposed CSF, and each CSF should stand on its own. This is because failure to achieve one CSF will result in the failure of a Data Warehouse project, regardless of whether the other CSFs have been achieved or not. Therefore, the interdependencies between the empirical generalisations should not exist.

Since the empirical generalisations are reflected by the theoretical conjecture, the theoretical conjecture should also be amended to be more accurate. The level of support for the empirical generalisations is summarised in table 5.3.

Table 5.3 The level of support for the empirical generalisations

Empirical Generalisation	Strongly supported	Moderately supported	Poorly supported
First empirical generalisation		✓	
Second empirical generalisation		✓	
Third empirical generalisation		✓	
Fourth empirical generalisation	✓		
Fifth empirical generalisation		✓	
Sixth empirical generalisation		✓	
Seventh empirical generalisation			✓
Eighth empirical generalisation	✓		
Ninth empirical generalisation	✓		
Tenth empirical generalisation			✓
Eleventh empirical generalisation		✓	
Twelfth empirical generalisation			✓
Thirteenth empirical generalisation		✓	

5.4 Refinement of The Theoretical Conjecture

5.4.1 Revised theoretical conjecture

Based on the analysis and discussion of the research evidence and the varying level of support for the empirical generalisations, the theoretical conjecture proposed in sections 2.4 and 3.3.3 has been refined, and is presented below. The rationale for the amendments is discussed in the next section.

The Critical Success Factors for implementing an EIS based on a Data Warehouse are:

- A clear link between the data information provided and the goals and performance measures of the business;
- The use of an appropriate approach for establishing the system objectives and business information requirements;
- The use of an iterative, prototyping approach for implementation;
- Active, demonstrated support and commitment from senior executives and the project team;
- Demonstrated value and benefit to the business; and
- The provision of good quality information to end users.

5.4.2 The basis for the proposed revisions to the theoretical conjecture

The need to *manage end user expectations* has been removed from the original theoretical conjecture, not due to the lack of support for it, but because it should fall away as a specific issue if the following change management mechanisms are in place:

- Active end user involvement and participation;

- Continuous communication and feedback; and
- Effective education, training, and awareness programs.

Furthermore, all of these change management mechanisms should form part of a good, holistic project management approach, and it should not be necessary to isolate them as specific issues. For this reason, *active participation of end users* and the *provision of adequate education and training* have been removed from the original theoretical conjecture. This rationale is partly justified by the poor and moderate support for the tenth and eleventh empirical generalisations respectively. The application of good project management is assumed to be a minimum pre-requisite for the successful completion of any systems development project, not just a Data Warehouse, and has therefore not been added to the theoretical conjecture proposed above.

The *management of political and cultural issues*, which was moderately supported, has been removed from the original theoretical conjecture. It is critically important that the appropriate culture and political environment is in place for a Data Warehouse to succeed, but the establishment of this environment extends beyond the Data Warehouse initiative itself. Furthermore, the resolution of cultural and political issues requires significant commitment from senior executives at the highest level, and is therefore encompassed, to some extent, in the empirical generalisation dealing with the commitment of senior executives.

The *resolution of data and security issues* has been removed from the original theoretical conjecture due to poor support for the empirical generalisation.

The provision of good quality external and internal information to end users has been changed to *the provision of good quality information to end users.* This was done as none of the respondents specifically mentioned the need to include external information in a Data Warehouse. However, since the quality of data depends on how well it meets the needs of senior executives, these needs may highlight the importance of external information in the future.

The *need for flexibility of the Data Warehouse* has been removed from the original theoretical conjecture due to poor support for the empirical generalisation.

Ease of use has been removed from the original theoretical conjecture, despite its moderate support, primarily because of the number of easy to use front-end tools available to end users. As the various front-end tools evolve and the demand for ease of use persists, it is expected that this will become less of an issue.

5.5 The Critical Success Factors for Implementing Executive Information Systems based on Data Warehouses

The aim of this research is to identify, from a practical business perspective, those critical factors that will contribute to the successful implementation of EISs based on Data

Warehouses. Therefore, the refined theoretical conjecture, together with the results of the data analysis and discussion, has been used to develop and propose the following minimum set of CSFs that must be achieved to successfully implement EISs based on Data Warehouses:

- There must be a clear link between the data / information provided by an EIS based on a Data Warehouse, and the goals and performance measures of the business;
- An approach, which is best suited to the specific circumstances of the business, should be used to establish the system objectives and business information requirements of an EIS based on a Data Warehouse;
- An iterative, prototyping approach must be used to implement an EIS based on a Data Warehouse;
- There must be active, demonstrated support and commitment from both senior executives and the project team when implementing an EIS based on a Data Warehouse;
- There must be demonstrated value and benefit to the business when implementing an EIS based on a Data Warehouse; and
- An EIS based on a Data Warehouse must provide good quality information to end users.

5.6 Review of The Aim and Objectives of The Research

To ensure that this research is complete, it is necessary to formally review and evaluate the extent to which both the stated and implied research objectives have been achieved. Table 5.4 lists the research objectives together with an assessment of their level of achievement and indicates that, as a whole, the research satisfies its aim and objectives.

Table 5.4 The level of achievement of the research objectives

Objective	Achieved?	Section
Establish those factors that must be achieved, as an absolute minimum, to ensure the successful implementation of EISs based on Data Warehouses	✓	**Section 1.4.1** The research problem, **Section 1.5** The aim and objectives of the research
Increase the current understanding of what is required for the successful implementation of EISs based on Data Warehouses	✓	**Section 1.6** Importance of the research
Put forward practical guidelines for consideration when implementing EISs based on Data Warehouses	✓	**Section 5.5** The CSFs for Implementing EISs based on Data Warehouses

5.7 Summary

Chapter five reviewed the extent to which the aim and objectives stated at the outset have been achieved, and the extent to which the research evidence supports the empirical generalisations.

There was varying support for the empirical generalisations, as well as interdependencies between them. Therefore, although all of the empirical generalisations were supported to some extent it was necessary to amend them, and to propose an amended theoretical conjecture. Based on the revised theoretical conjecture, the CSFs for implementing EISs based on Data Warehouses have been proposed.

CHAPTER SIX: LIMITATIONS AND FURTHER RESEARCH

6.1 Introduction

Chapter six highlights some of the limitations of the research and provides suggestions for further research.

6.2 Limitations of the Research

This research has provided the following valuable insights:

- It has provided practical and theoretical guidelines regarding what factors have to be achieved, as an absolute minimum, to ensure the successful implementation of Executive Information Systems (EISs) based on Data Warehouses; and
- It has increased the current understanding of what is required for the successful implementation of EISs based on Data Warehouses.

It is, however, recognised that there are limitations to the research, brought about by the time available to complete it, and the relatively narrow scope. These limitations are discussed below.

6.2.1 Researcher's interpretations

To avoid biasing the views of the respondents, the interview guide was not used until the respondents were comfortable that they had covered what they thought were the Critical Success Factors (CSFs) for implementing an EIS based on a Data Warehouse. The interview guide was only used to prompt discussion on those issues that were identified in the literature review as important, that the respondents did not raise. Furthermore, during the analysis of the data, every care was taken to ensure that an objective view was taken of the themes that emerged. However, it is recognised that a primarily qualitative research study will always reflect the inherent biases, and interpretations of the researcher at the time of the study. Therefore, it is conceivable that other interpretations of the results could exist, and other deductions could have been made.

6.2.2 Sample size

Although the sample size of respondents was as large as possible for the time available it was only possible to conduct eighteen interviews. Therefore, the research results cannot be generalised to the entire population of Data Warehouse implementations. While it would have been better to conduct forty to fifty interviews this would not have been possible for two reasons:

- The time constraint; and

- Many respondents estimated that there is a maximum of thirty Data Warehouse implementations in South Africa.

Although the sample size is limited, the research results stand up to scrutiny because the respondents raised all of the issues identified as important in the literature review, and also provided additional insights.

6.2.3 Data collection

The respondents interviewed were from a variety of organisations in different industry sectors. In total fifteen different organisations, from nine industries were represented. There were five respondents from three different banks, and four respondents from four different organisations in the retail industry. Therefore, the banking and retail industries were most strongly represented and the research results may have been biased towards the issues that prevail in these environments. However, the respondents from the organisations in these industries did not raise any issues over and above the issues raised by the respondents from the other industries, and it is felt that any bias they may have introduced is minimal.

6.2.4 Sample selection

The respondents for the pilot interviews were selected from the list of speakers at the Data Warehouse and Knowledge Management '98 conference, and additional respondents were nominated using the snowball sampling technique. Using this approach it is not possible to generalise the research results across the entire population of Data Warehouse implementations. A random sampling technique may have been more appropriate, as all potential respondents would have had an equal likelihood of being selected, and the results could then have been more general.

6.2.5 Type of respondents

Nine of the respondents had an IS/IT background and the other nine had a business background. Most of the respondents were at an upper middle, or senior management level within their organisation. Unfortunately, it was not always possible to interview senior business executives, because potential respondents at senior executive level were not always available, or were not prepared to be interviewed. It is, therefore, possible that valuable insights may not have been mentioned. While this may have been a limitation for this research it provides a potential area for further research, viz. to investigate the difference between what senior business managers and executives, and IS/IT managers believe to be the CSFs for implementing EISs based on Data Warehouses.

6.2.6 Data analysis

Three 'levels' were used to establish the support for the empirical generalisations: Strongly Supported, Moderately Supported, and Poorly Supported.

The choice of the number and naming of the levels, as well as the method used to define the bounda between these levels was somewhat arbitrary. There is a risk that some empirical generalisations could have been incorrectly classified by being supported to a greater or lesser extent than was discussed in chapter five. This risk was minimised by taking a holistic view of the support for the empirical generalisations, based on the analysis and discussion in chapter four, and by using the 'levels' as a guide, rather than as a rule.

6.3 Further Research

6.3.1 The most appropriate use of a Data Warehouse

Twenty eight percent of the respondents felt that Data Warehousing as a concept is still maturing. Furthermore, only one respondent indicated that his organisation had implemented its Data Warehouse with the express intention of using it as an EIS. Initially it was felt that the research study would be too broad if it focused on all of the potential uses of a Data Warehouse. However, the research results suggest that the respondents saw Data Warehousing as an enabling element of an overall technology infrastructure, rather than as a technology for a specific application. Therefore, it is necessary to investigate the primary use of Data Warehousing, and then to establish the Critical Success Factors for implementing a Data Warehouse for this purpose This may reveal subtleties that were not revealed by this research.

6.3.2 Approach to understanding the system objectives and business information requirements

The respondents mentioned four approaches that can be used to establish the system objectives and business information requirements. The specific management style and culture within each organisation that adopted a particular approach was not discussed, as it was outside the scope of this research. However, since the approach adopted is a CSF, and certain approaches may only be appropriate to certain management styles and cultures, it is necessary to investigate which approaches are most appropriate to which management styles and cultures. Taking a broader view, the relationship between the management style and culture within an organisation, and the success of Data Warehouse implementations should also be investigated. This may reveal that when certain management styles and cultures prevail there is an increased risk of failure of a Data Warehouse initiative.

6.2.6 Data analysis

Three 'levels' were used to establish the support for the empirical generalisations: Strongly Supported, Moderately Supported, and Poorly Supported.

The choice of the number and naming of the levels, as well as the method used to define the boundary between these levels was somewhat arbitrary. There is a risk that some empirical generalisations could have been incorrectly classified by being supported to a greater or lesser extent than was discussed in chapter five. This risk was minimised by taking a holistic view of the support for the empirical generalisations, based on the analysis and discussion in chapter four, and by using the 'levels' as a guide, rather than as a rule.

6.3 Further Research

6.3.1 The most appropriate use of a Data Warehouse

Twenty eight percent of the respondents felt that Data Warehousing as a concept is still maturing. Furthermore, only one respondent indicated that his organisation had implemented its Data Warehouse with the express intention of using it as an EIS. Initially it was felt that the research study would be too broad if it focused on all of the potential uses of a Data Warehouse. However, the research results suggest that the respondents saw Data Warehousing as an enabling element of an overall technology infrastructure, rather than as a technology for a specific application. Therefore, it is necessary to investigate the primary use of Data Warehousing, and then to establish the Critical Success Factors for implementing a Data Warehouse for this purpose. This may reveal subtleties that were not revealed by this research.

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6.3.3 Consultant-led implementation approaches

Two of the respondents were from consulting organisations in the IT services industry that concentrated on implementing Data Warehouses These respondents argued strongly in favour of a methodology driven approach to the implementation of Data Warehouses. A comparison should be made between what consulting organisations believe to be the CSFs for implementing Data Warehouses and what non-consulting organisations, that have implemented Data Warehouses, believe to be the CSFs. Furthermore, the relative success achieved by each type of organisation should be investigated.

6.3.4 Long term success of Data Warehousing

Most of the respondents interviewed were involved in Data Warehouses that were being implemented, or that had recently been implemented. The number of Data Warehouse implementations in South Africa will increase, and existing Data Warehouse implementations will begin to reveal the issues associated with ensuring their long term viability. An area for research is to compare the CSFs required for the successful implementation of a Data Warehouse with the CSFs required for continued post-implementation success. However, it will only be practical to conduct this research a few years from now.

6.3.5 Interrelationships between themes

The content and interpretive analysis revealed a number of themes that the respondents felt were important. These themes were grouped together into logical groupings, based on whether they were related to:

- Additional insights provided by the respondents, which were not revealed by the literature review; or
- The empirical generalisations.

The analysis revealed that there were interdependencies between themes within each logical grouping, and between themes in different logical groupings. The theoretical conjecture was refined to reflect the insights revealed by the data analysis to make it more useful. However, to better understand the interdependencies, isolate the dependent variables from the independent variables, and to obtain greater clarity on the contribution of these variables to the success of EISs based on Data Warehouses. the following research should be conducted:

- Investigate the relationship between the approach to establishing the system objectives and business information requirements, and the approach to implementing an EIS based on a Data Warehouse;
- Investigate the relationship between the actual and perceived value of a data Warehouse, and the commitment of senior executives to its implementation;
- Investigate the relationship between the quality of data that resides in a Data Warehouse, and the commitment of senior executives;

- Investigate the relationship between user participation and user expectations;
- Investigate the relationship between user expectations, and education and training; and
- Investigate the relationship between political and cultural issues, and senior management commitment.

Furthermore, each of the themes mentioned by the respondents listed in table 4.2. (Section 4.4) could form the basis of a research study on its own.

6.3.6 Further refinement of the empirical generalisations

In chapter two an extensive literature review was conducted. The results of the literature review were presented as a narrative description, which was used as the basis for developing the theoretical conjecture. Empirical generalisations were developed from the theoretical conjecture and were tested against the research evidence collected. From this a refined theoretical conjecture was developed and presented in chapter five. Since the research process is iterative, the refined theoretical conjecture should form the basis of empirical generalisations that should be tested against further research evidence.

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APPENDIX A: INTERVIEW GUIDE

1.1 Section One: Demographics

1. Name of organisation
2. Industry sector
3. Name of interviewee
4. Positional title of interviewee
5. Area / department of interviewee in the organisation
6. Size of organisation
   6.1. Number of employees
   6.2. Number of divisions
7. No of EIS users
8. No of Data Warehouse users
9. EIS and Data Warehouse hardware and software platforms (including analysis and decision support tools)

1.2 Section Two: Use of the Data Warehouse

1. What is your understanding of an EIS?
2. How long has your organisation been using a Data Warehouse?
   2.1. How long did it take to implement the Data Warehouse and is the implementation complete?
3. Is your Data Warehouse being used as an EIS, and why (i.e. what are the advantages of using a Data Warehouse rather than a bespoke developed or packaged EIS)?
   3.1. How long has it been used as an EIS?
4. If not, could your Data Warehouse be used as an EIS?
   4.1. Are you planning to use your Data Warehouse as an EIS?

NOTE: *Critical Check Point* - decide whether interview should continue if the Data Warehouse is not and will not be used as an EIS

5. What else is the Data Warehouse being used for?
6. Was the project conceived and approached as an EIS project or as a Data Warehouse project?
   6.1. Has this made any difference to the approach or success of the project?
   6.2. Was it a strategic project?

1.3 Section Three: Critical Success Factors

1. How important is the achievement of business objectives?
   1.1. To what extent have the business objectives / user requirements been achieved (i.e. is the system valid / useful?)?

2. How important is the approach used to establish the system objectives and business / information requirements?
   2.1. What approach was used?
   2.2. Who should be involved in establishing the business requirements?

3. How important is the approach to implementing the system (e.g. prototyping vs big bang)?

4. How important is active, demonstrated support and commitment to the project (Championship, ownership, and sponsorship)?
   4.1. Who should sponsor and own the project?
   4.2. Who should champion the project (who should drive it - Business or IT)?
   4.3. How important is it to clearly define and allocate system, and information / data ownership and to whom should this be allocated?

5. How important is effective communication?
   5.1. How should interest / awareness be generated, maintained?
   5.2. Who should be involved in communications (e.g. all stakeholders vs key stakeholders)?

6. How important is it to manage the expectations of the end users?
   6.1. How should this be done?

7. How important is it to manage the politics?
   7.1. What type of political issues are generally involved?
   7.2. Who should resolve political issues?
   7.3. How should they be resolved (e.g. what should be done if there is a lack of appreciation of the system / information and its worth, and what should be done if there is a high degree of resistance to change?)?

8. How important is it to address information / data security issues?
   8.1. What data / information access philosophy should be adopted (e.g. 'information is a resource' vs 'need to know')?
   8.2. Who should decide this?

9. How important is it to demonstrate value / benefit to the business?
   9.1. Is your EIS a success?
   9.2. How is this success measured?
   9.3. Who measured this success (IT vs business)?
   9.4. What value was added (tangible and intangible)?
   9.5. What were the actual vs predicted benefits?
   9.6. How important is it to demonstrate economic value add or ROI? (i.e. that the system cost less than the value it provides)?
   9.7. How important are tangible deliverables?
   9.8. How important is it to measure the benefits?

10. How important is it to provide good quality information (i.e information that is available, confidential and reliable)?
    10.1. What form of information should be included (text, image, graphics)?

10.2. What type of information should be included (external, internal, hard, soft)?
10.3. What level of detail should be included?

11. How important is user participation?
    11.1. Who are the users?
    11.2. Who should the users be (everybody vs a select few)?
        11.2.1. If the user base should be a select few, who should they be (senior executives, business analysts)?
    11.3. When should they be involved (to SDLC)?
    11.4. How should they be involved?
    11.5. How important is the identification of the correct target market and why?

12. How important is education and training of the user base ?
    12.1. How should this be done?

13. How important is the quality of the front-end tools provided?
    13.1. How important is it that EIS functionality and capabilities should be customised for each user?
    13.2. How important is it to standardise on a user interface (e.g. one suite of tools versus many)?
    13.3. How important is functional richness vs ease of use?

14. How important is the flexibility of the EIS / Data Warehouse (i.e. ability to change with changes in the user base and market requirements)?

1.4 Section Four: Issues Specific to the Use of Data Warehousing for EIS Purposes

1. What specific issues arose out of using a Data Warehouse rather than another architecture for your EIS (what were the disadvantages)?
2. If you could develop your EIS again would you use a Data Warehouse?
   2.1. What would you do differently?
3. In your experience are there situations where Data Warehouses are particularly well suited to EIS?
4. In your experience are there situations where Data Warehouses are not appropriate for use as EIS?

APPENDIX B: EXAMPLE INTERVIEW

During the interview each respondent was assured of complete confidentiality. Therefore, all means of identifying the respondent or the organisation he / she works for have been removed from this interview transcript.

1.1 Section 1: Demographics

1. *Name of organisat*
2. *Industry sector*:
3. *Name of interviewee*:
4. *Positional title of interviewee*:
5. *Area / department of interviewee in the organisation*:
6. *Size of organisation*
   6.1. *Number of employees*:
   6.2. *Number of divisions*:
7. *No of EIS users*:
8. *No of Data Warehouse users*:
9. *EIS and Data Warehouse hardware and software platforms (including DSS and ROLAP/OLAP tools)*
   9.1.Data Warehouse:
   9.2.Front End tools:

1.2 Open Discussion

Interviewer
Tell me about your involvement in Data Warehousing?
Interviewee
I got involved in Data Warehousing back in 1991, for Company A at the time. Back then we never really had much of an idea; Data Warehousing wasn't as formally defined as it is today. Back then a lot of people didn't even know about Data Warehousing. There weren't really any products around, and the relational databases weren't as up to scratch as they are today. At the time the team followed the Bill Inmon approach to Data Warehousing. It was quite a success and we got invited to speak at the Arlington Data Warehousing conference in Washington. Since then I went to work in the States, and built quite a few Data Warehouses for some really interesting companies. One was a fairly large company called Company B, who distribute music videos; they distribute just about anything to do with the entertainment world. I built quite a few Data Warehouses for a couple of the Telcos: I was involved with the Company C one, and with the Company D one. I then came back here and got involved in the Company E Data Warehouse. I've been in the Data Warehousing field for quite a while now and have built some small ones and some big ones.

Interviewer
Have you only been involved in the Company A and Company E Data Warehouse initiatives, in South Africa?
Interviewee
No, through Company F we've been involved in quite a few other Data Warehouses around the country. In fact we've just finished one at Company G. We've been busy at Company H, and at Company I, Company J down in Cape Town, and Company K. These are really the ones that I've been involved in. Company F has been quite extensively involved in the Data Warehouse arena. Last year Company F hosted the Data Warehouse conference in Swaziland.

Interviewer
Tell me about Company E
Interviewee
Company E is in most segments of the retail market. It consists of three companies: Company L, Company M and Company N. They're part of the Company O group. Company O owns Company E in conjunction with owning Company P and Company Q.

Interviewer
What is your role in the project?
Interviewee
I'm the Data Warehouse Architect here at Company E.

Interviewer
What does your role entail?
Interviewee
I look at all the aspects pertaining to the Data Warehouse: the front-end, the back-end, the transformation tools, and the strategic direction of the Data Warehouse.

Interviewer
How many people does Company E employ?
Interviewee
We've got round about 18 stores around the country. You've been to the Company L store; there's a good few hundred people in each store, and then this is really the head office, this is just the Company L one. In Company M they've got about 30 odd stores with a good few hundred people in each of those stores as well. That gives you a fairly large retailer. Company N as you know is involved in stationery and that type of thing. I'm not sure how many stores Company N has - they've recently been acquired by Company E. Because the Company N acquisition is so new at this point the guys are really trying to figure who's going to be responsible for what, and how's it going to work within Company E.

Interviewer
How many EIS users do you have?
Interviewee
We don't have very many EIS users. We've currently got 12 and we plan to have 20.

Interviewer
Who are they?
Interviewee
They would be our executive management level people and Strategic Business Unit executives.

Interviewer
How many Data Warehouse users do you have in total?
Interviewee
On the rest of the Data Warehouse we've currently got 200 users and we need to bump that up by another 50 users. This is certainly excluding Company N since they weren't on board with this particular initiative. We built this first phase of the Data Warehouse only for the Company L users, for the Company L division. It does not include Company M at this stage, or Company N.

Interviewer
What are your plans with respect to Company M?
Interviewee
We really are lead by the business needs of the organisation and the business would like us to attack some other areas within Company L before we move on to Company M. Within the next 6 months we won't be taking on Company M. Company M is also busy with some SAP development of their own. They are busy moving over to SAP; which they'd like to sort out before they get involved in Data Warehousing.

Interviewer
Tell me about the tools and technology you are using
Interviewee
For our executive users we provide a Visual Basic like front-end developed in a product called DSS Agent. It's the DSS EIS front end, and it has really big buttons, 'Fisher Price' buttons, and provides the guy with click-the-button, see-the-report, click-the-button, see-another-report on the business, on various functions within the business. The front-end is pre-built, fairly static. They can request other functionality on the front-end, but then it would require some development from our side. Although the development can be very quick (the turnaround) essentially it's not something dynamic that they can change themselves automatically. They seem pretty happy with that. The front end for the executives runs off a Windows-based tool. It's a GUI tool so there's nice pictures and all that type of stuff on the top, very visual. It's used for visualisation of trends, visualisation of patterns, visualisation of reports, that type of stuff. The reports are quite high-level, for example, the top three selling products in the stores, top selling stores within the country, hot spots in the country, all that type of thing.

Then for the rest of the 200 odd users we provide them with a Web-based tool called DSS Web. They've got quite a lot more reports that they can run. The reports are dynamic and they can construct to a certain extent, and do analysis over the Web through the reports. Its dynamic HTML, dynamic Java applets that run and generate the various

reports. It allows drill down, drill across, that type of stuff over the Web. The reason for using the Web, certainly a thin client, is that they don't need any sophisticated software on their PCs. They just need a browser and a TCP/IP connection and they're A for Away, which is really great. Because it's also centrally co-ordinated in a centralised architecture as opposed to a distributed one, the scalability of it is significant. You can go from 100 to 500 users in a day if you had to because it is totally scaleable and the cost is certainly absolutely minimal.

The users, not the executive users, do a lot more in-depth type of analysis work. That goes all the way down, from the middle management, which includes regional buyers, regional managers. etc., right down to the actual store manager himself. He can manage the store himself and get information about the stores; what's selling, what's not selling in the stores. Then we've got another group of users that we are setting up right now, what we would call our data mining aspect, and those are our real power users. We've got a data mining tool called RedBrick that we can use. We haven't implemented it yet, we are thinking about it, but it is an automated tool that would go against the database to bring out clusterings, associations, means, mods, modes, types of data patterns. This is generally something that a very small group of very well trained people use. We foresee these people as being involved in the "statistician" type of work. At that level of analysis you can really make the data say anything you like. You know the data could be right but depending on what type of regression analysis technique you use on that data, you can turn it into anything. You need to know what you doing in the data mining arena otherwise you could end up in some serious trouble. That's really our user profile and how we see our users using the Data Warehouse, the executives and all the rest.

Interviewer

What do you believe to be the Critical Success Factors for implementing an EIS based on a Data Warehouse? These are the minimum factors that you absolutely must get right to succeed

Interviewee

Certainly, it's driven by the business. The Data Warehouse is housed in IT, but essentially the whole process is driven by the business, the business' needs, and their absolutely burning issues within the organisation. Whatever's burning the business and stuff that the execs have to solve, things relating to the business, those are the issues. A lot of them can be resolved from the Data Warehouse, and only from the Data Warehouse. If you think about the types of decisions that need to be made, whether you need to open another store in another area, you need a lot of information pertaining to that from an executive point of view; what type of customer profile is going to visit the store; is it really needed?, what are the sales patterns in the areas around where you propose to put the store?; what's the buying patterns of those people?; who's this going to service?; what are the products you're going to stock in the store?. Those types of things are almost impossible to answer without a Data Warehouse. Even on your sales and category management - it's pretty crucial.

Interviewer
How did you go about establishing the executives information requirements and how important is the approach that is used to do this?
Interviewee
We had a number of workshops initially because what we wanted to do was get an idea of the size of our Data Warehouse by the end of the 1st year and the end of the 2nd year. We then held a number of workshops with the various levels of management, the executives and the SBUs, and we asked them what their burning issues were. They came up with many, and we then asked them to identify which ones were the top ones. They gave us the top ones and we did a similar thing with the executives. Eventually by going between them we got them to identify which ones they would like resolved, and they said: "If we can resolve this, we're in business." We asked them how much Return On Investment (ROI) they estimated making at that. They said: "That's very difficult," but we asked them to just give us an idea. We told them we need to have some idea and so we got some ROI ideas, what they were looking at by the end. So we said to them: "Fine: if we resolve this, provide you with that, this is the potential ROI that we are going to be getting back from this thing, or this is the ROI area that we can be looking for results from." So we had a measurement thing for ourselves, we knew we would know when we've done it and we would then be able to look either in areas for ROI to see how well we did it, or we'd have some actual facts on how much we brought back, how much the Data Warehouse brought back.

Interviewer
How do you measure the success of your Data Warehouse?
Interviewee
We looked at the ROI achieved and we got back to the executives. That's what we're doing right now, we're into our next session, if you like, where we go back and say: "Fine, we might have accomplished those ROI's but in the business, how's it changed the business?" But we've seen an impact that the Data Warehouse has had within the business itself, and it's changed people's thinking in the business, which wasn't there before.

Interviewer
In what way has it changed people's thinking?
Interviewee
In workflow, and in workflow within the actual business. People are using it to do their various business functions that before we never thought would be included in this thing, or that they would ever consider using the Data Warehouse for this function or that function or whatever it is. Those really are actual benefits themselves, spin-off benefits that you didn't anticipate getting back.

Interviewer
What else is critical for the success of the Data Warehouse?
Interviewee
Once you understand what the burning issues are, and what you need to do to resolve them, you obviously need a methodology to follow, to take you from point A to point Z,

to do this thing. You need to follow a methodology that works, and you've proved it does work, which we did. We had a methodology, we've got a methodology in Company F that we follow. It covers every aspect of the Data Warehouse right from the beginning, in fact. That includes the workshops to the actual end result of doing a post implementation review to find out if you met your project Critical Success Factors, and what some of the ROI's were that you received.

Interviewer
What specifically does that methodology cover?
Interviewee
Obviously the whole bang shoot. Our methodology is prescriptive in the deliverables and descriptive in the processes of obtaining those deliverables. There are some results that you have to have achieved by the end of each phase, but within each organisation things are different. Some times you need to do things differently, so we say: "As long as by the end of doing this we land up with that document or we land up with that as being your end product to this particular phase, that's fine". As long as you've got those things, because without those things you're not going to continue and achieve success.

Interviewer
Would you regard your implementation as being a success in the eyes of the executives?
Interviewee
We would like to see it come from the business, to say whether it's been a success or whether it hasn't. From our point of view certainly we've done everything that we should have, and we've met what was required of us to do, but beyond that really it's a business thing. You can be given a spec, run off to some little room somewhere and write a program and come back and say: "Here's the program that you asked me to write. Has it been a success?" From your point of view it's a success because you've done what you were asked to do. Is it really a success in the overall picture of the business? If while you were doing this they had a change, and you never consulted them and you weren't working with them, and they can't use this thing then it wasn't a success. So its really for the business to determine whether you were successful or not.

Interviewer
What feedback have you had from the business?
Interviewee
We've got a lot of feedback in that respect. The types of things we judge ourselves being successful at is in the other ROI that's been coming from the business. Things like when the store gets new PC's and their PC's haven't got a browser they can't access the system. Well, they say they can't continue working without access to the Data Warehouse. You suddenly realise WOW!, this is that important. This has become mission critical, I've now given the business something that's mission critical, that's equally important as having a Point Of Sale system in your store. Then you can honestly say to yourself: "I've given real value to the organisation".

Interviewer
Is there any thing else that you regard as critical?
Interviewee
No.

1.3 Discussion of Critical Success Factors Cited in the Literature

Interviewer
What I would like to do now is go through those issues that are highlighted in the literature as critical to the success of Executive Information Systems and Data Warehouses. I will only raise those issues that we have not yet discussed as I would like your opinion on how important they are. For example, in your opinion, how important is the implementation approach?
Interviewee
Our methodology prescribes that you have to do it piece-meal and I've never built a Data Warehouse where you build the whole Data Warehouse for every single subject area all at once. I haven't read any literature where that's been a resounding success. The rest of the guys out there that are doing it as well, reckon you do it subject by subject area. Pick a particular subject area and do that, and you then add it on within the overall architecture that you have. I would say that's pretty important and almost a given. I have never come into a situation where someone said: "I want to do this thing one shot!". That's real foolish.

Interviewer
How many people are currently working on the D. Warehouse?
Interviewee
We've currently got two support personnel, who support our users. We've got two developers that develop new phases of the Data Warehouse, and we've got myself, the architect, and we've got one project manager to make sure we all keep talking to each other; that we don't beat each other up.

Interviewer
How important is effective communication?
Interviewee
Oh yes, it's critical. If you don't get user involvement from the start, and keep them involved you've got problems. It's been one of our absolute priorities, a given thing in our case, that our users are involved at all times. Even in the selection of our tools, the whole development cycle, we involved the users very heavily at all times.

Interviewer
What about the expectations of the end users?
Interviewee
With their heavy involvement, that sort of took care of their expectations as well because we had a prototype and then we built on the prototype. Initially we built a strawman, then we continued fattening out the strawman so the users were seeing, as this thing was

being developed, what it looks like, what its going to look like, what it can do, what it can't do, so there was no big surprise at the end when we gave it to them. That didn't happen, they knew exactly what it looked like, they had in fact built it. We provide the expertise behind it, but essentially the users built it, so they got what they wanted.

Interviewer
Were there any major political issues that you had to manage?
Interviewee
That wasn't a problem here. We had buy-in from the top all the way down, and with our user involvement the executive team knew where we were going. They filtered that down to the rest of their teams, so we all knew where we were going and we all knew why we were going in that direction, and where we were going to land up, and what we were going to be doing at the end. So we never experienced anything like that.

Interviewer
How important is providing good quality information from the Data Warehouse?
Interviewee
I think it's a very difficult thing to do. Do you say: "Well, we're going to improve the quality of the information first before we build the Data Warehouse"?, or do you provide them with the data that is in the organisation that they using at the time? I strongly feel that you provide them with the information and then provide a mechanism for them to get that data up to scratch. A lot of the users have never been able to see the data as such. They've seen some of the data in the form of reports and stuff that comes out on a regular basis, but it's effectively been hard-coded to come out in a particular form, or its produced from a screen or something like that, but they haven't seen the actual raw data as such. The quality of data is very important, but if you make the user aware that this is the data they are using, and this is their data that they are seeing every day, and you ensure that what you are showing them is the real data, and you have your audit procedures in place, the users take it on themselves to improve the quality.

Interviewer
How important is the training of end users?
Interviewee
The training has never stopped, and will never stop. From when we initially had our session with users and the training of what a Data Warehouse is, what it can do, to getting their hands on a tool, to start using a mouse, to start pointing and clicking, that whole training cycle is a never-ending thing. New people come into the organisation and join in and they don't know what the Data Warehouse is. Then you have upgrades of software. The training issue is never-ending; you never end training your users.

Interviewer
How important is the level of computer literacy of end users?
Interviewee
Kids of three can use technology if it's put across correctly. No matter what level of computer literacy your user's at, you can make your system so that he can use it. Granted, you have to be able to read but certainly I don't think its any excuse to say:

"Well my users need to be computer literate or they need to be at that stage of literacy", or whatever it is. Some of our users are more advanced than others, but we've got the tools in place for them to use. The ones that just want to click the button, they can do that. The others that want to go and create their own reports and do their own analysis and drill off into the never-ending future, they've got the tool to do that as well. So at each level as long as you provide them with the right tools and the right technology they will be fine. Their job is not to take over some IT function of being an SQL guru so they can write SQL, just as much as the IT guys are not moving into the business so that we can do financial planning. I would rather leave the financial planner over there and leave the DBA over here; each has his own task to do.

Interviewer
Who does the training?
Interviewee
Our two user support people do the training. The training is done on a one-on-one basis, and usually involves a couple of hours, in some cases a couple of days.

Interviewer
Who's involved in the scrubbing, cleaning, and loading of the data into the Data Warehouse?
Interviewee
Essentially that's our support team. Our daily routines that run every day are probably about 95% automated. The whole loading procedure, through the transformation tool, the scheduling of it and all that type of stuff takes place automatically. In the morning we get an audit report of what ran the previous night, what didn't run etc., etc. It moves the data from the source all the way through into our Data Warehouse and then does all the balances and checks and everything else to make sure that it's all up to scratch. We've got a repository where we store that type of information, so if anyone needs to go and look at it they can see exactly what happened with that job that ran here, that ran there. That all runs at night in an automated fashion. The whole process takes about 2 hours to run.

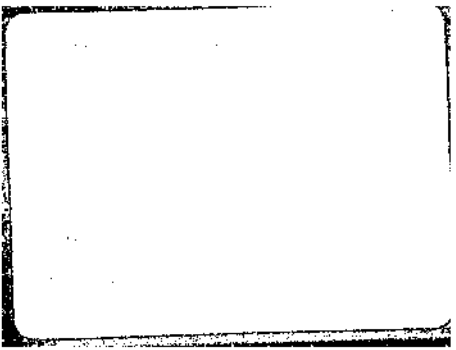
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Author: Bestbier S
Name of thesis: The critical success factors for implementing Data Warehouse based executive information systems

PUBLISHER:
University of the Witwatersrand, Johannesburg
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