Exploring the Critical Success Factors of Business Intelligence System Implementation:

An Empirical Study and Proposed Integrated Model

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2014

A thesis submitted in partial fulfilment of the requirement for the degree of Doctor of Business Administration DBA

ABSTRACT

Business intelligence (BI) systems have become top priority for IT spending because of the perceived potential benefit of such systems to business competitive advantage. However, BI systems are costly and complex to implement with many cases of failure, yet few empirical investigations exist in this evolving area of study.

This study explores and evaluates the critical success factors (CSFs) that influence business intelligence system implementation. It adopted a mixed method research approach in three distinct stages. The first was an extensive literature review of the phenomenon followed by the development of the research conceptual framework. The second was a survey of major stakeholders (N=102) familiar with the process of business intelligence system implementation to confirm and validate the critical success factors and other research constructs from the literature review stage. The third was an interview case study in four UK organisations that had implemented a BI system to understand the process and challenges involved, and how the critical success factors are applied in real- life projects.

Sixteen CSF variables were derived from the literature and validated in a BI success model. The model posits that to effectively implement a BI system, organisations must understand: a) the interrelationship between the CSFs, b) their relative importance, and c) which sets of CSF have the greatest impact in realising a BI success objective.

The study used factor analysis to explore the variable relationships and overall impact, while thematic content analysis was applied to the interview data to gain an insight into the BI implantation process to complement the survey findings.

The study found that the CSFs of business intelligence implementation are of four major interrelated cluster dimensions. These are organisational, process, technical and user-related critical factors, which should be considered from the perspective of their interdependence to maximise their input. The study also found that the CSFs have their unique challenges, when it comes to BI system implementation.

The findings and the resultant model would benefit practitioners and organisations intending to implement a business intelligence system and how to better align their BI objective with the critical success factors. It would also benefit others seeking a greater understanding of this emerging field of study.

Methodology: Mixed Methods Research; Thematic Content Analysis; Factor Analysis; Regression Analysis; Interview Case Study, Survey, Triangulation.

Key words: Business Intelligence (BI) System; Information Management System; BI Success Attributes; Critical Success Factors (CSFs); Organisational, Process, Technical and User Related Critical Factors.

DECLARATION

I declare that this thesis was carried out by myself and does not contain without acknowledgement any material previously submitted for an award of a degree or diploma in any university; or any material previously published or written by another person. I also declare that this thesis has not been submitted for the award of any degree in any university and I take full responsibility for the content of this thesis.

APPRECIATION

I would like to thank my research supervisors Dr. Richard Van Den Berg and Dr. Serhiy Kovela for the brain storming sessions we had, for painstakingly reading through the write-ups, their comments, invaluable support and guidance towards producing this doctoral thesis. They had guided me from the first stage of my DBA proposal, to completing the final DBA thesis and I will always cherish their guidance and assistance. I would also like to express my appreciation to Professor Stuart Fitzgerald for finding the time to read through the thesis, his comments and acting as my mock-viva examiner. The exercise did help in building my confidence.

I would like to thank my friends and family for their support, especially my wife who wondered why I needed another degree, yet showed her unending support and understanding. To my two boys for their understanding especially as the programme crept into quality family times. Finally, my thanks go to almighty God for his kindness and through whom all things are possible.

DEDICATION

This thesis is dedicated to

My Father,
for his encouragement, wisdom and courage

My Mother,
for her endless prayers and unending love.

My Wife and Children
for their love, understanding and patience.

To almighty God
for who I am, and who made it all possible.
To God be the glory for taking me this far

TABLE OF CONTENT

List of Figures

List of Tables

List of Abbreviations

BI - Business Intelligence

BIS- Business Intelligence System

CRM - Customer Relationship Management System

CSF – Critical Success Factor

CSA – Critical Success Attribute

DNA - Data Needs Analysis

DSS – Decision Support System

DW - Data Warehouse

ERP - Enterprise Resource Planning System

IS - Information Systems

IMS - Information Management System

ISP - Independent Software Vendor

IT - Information Technology

KPI - Key Performance Indicator

MIS - Management Information Systems

OLAP - Online Analytical Processing

OLTP - Online Transactional Processing

ORR - Office of the Railway Regulator

PNB - Perceived Net Benefits

TfL - Transport for London

SAS - Statistical Analysis Software

SPSS - Statistical Package for Social Sciences

QUADAS – Qualitative Data Analysis Software

CHAPTER ONE: INTRODUCTION

1.1 Background

In today's knowledge-driven and competitive economy, the quest for information, its timeliness and the quality of data have become increasingly crucial to organisations' profitability, growth and survival (Hostmann, 2007; Williams & Williams, 2007; Eckerson, 2012). Business needs to know what is happening right now, and act fast to determine what should happen next. However, this information quest has also led to a widening gap between the amount of data often acquired in disparate systems, and the efficient utilisation of such data (Williams & Williams, 2007; Davenport et al., 2010).

Identifying and collating information needs has always been, and still is, one of the most difficult tasks in information management. Accenture, a global management consultancy group, in a 2006 survey of 1,000 middle managers from top companies, found that managers spend up to two hours a day searching for information and more than half of the information they find is not useful. The study also revealed that more than half (57 per cent) of the respondents said that having to go to numerous sources to compile the information needed for effective decision-making is the most difficult aspect of their job (Accenture Information Service, 2006). In fact, the ease with which organisations can now gather data over the internet, whether from online sales systems, customer relationship management systems, procurement systems, financial or human resource management systems etc., has created an information overload and the challenge is how to unlock the potential of the huge amount of data gathered in organisations' information management systems (Chen et al., 2012). This is where business intelligence system becomes useful.

Business intelligence (BI) refers to the technology and processes that enable organisations to aggregate data from heterogeneous sources to provide a single but multi-dimensional view of business operations and assist managers to optimise their decision-making process (Rajan, 2008; Isik, 2009; Yeoh et al., 2009). Technology and software elements for data warehousing, data mining, online analytical processing (OLAP) and interactive reporting tools, enable the use of business intelligence (Wang & Wang, 2008; Yeoh & Koronios, 2010; Eckerson, 2012). The central theme of BI is to help organisations harness the value of their data asset in order to gain competitive advantage, by making the relevant information available to those who need it, when they need it, where they need it, and in the format that is most useful (Davenport & Harris, 2007; Hawking & Sellitto, 2011; Chen et al., 2012; Ashrafi et al., 2014).

The concept of BI in itself is not new. It has actually been an integral part of the traditional field of business studies including finance, marketing, human resource, management and economics. Businesses have always produced yearly, quarterly and monthly finance and marketing reports. What is new however, is the development of dedicated BI tools, the centralisation of corporate data from different departments and the fusion of intelligence across independent and multiple fields to reveal something new about organisations' operations (Moss & Atre, 2004; Hostmann, 2007).

The potential benefits of business intelligence cut across industrial sectors, from retail to banking and finance, healthcare delivery, telecommunications and transport, among others (Hostmann, 2007; Sheriff, 2009; Budhwar, 2007; *The Economist*, 2011; Ashrafi et al., 2014). For instance, banks use business intelligence to analyse credit risk by scoring an applicant's ability to pay loans based on the data held on past financial transactions. Credit card companies use rules derived in BI systems to mine data held on purchases, and they can identify fraudulent transactions with a high degree of accuracy and alert card owners accordingly. In retail, BI enables organisations to rationalise operations across sales, products, pricing, customer profiles, shop floor usage and staffing, which enables effective decision-making regarding inventories held, cost reduction and profitability (MicroStrategy, Inc. 2009; Budhwar, 2007). Mobile phone companies use business intelligence to attract potential customers from rival networks by offering better contracts based on call patterns routed through their networks. In healthcare, BI is used to analyse digitised healthcare records to spot and project health trends and to evaluate the effectiveness of different treatments (Ashrafi et al., 2014). The potential benefits of BI systems in identifying patterns, trends, proportions, comparisons and relationships that enable timely and efficient decisions are enormous. Studies have found that given the right implementation, business intelligence can improve profitability (Williams & Williams, 2007), reduce costs (Pirttimaki et al., 2006), and improve operational efficiency (Hawking & Sellitto, 2011; Dawson & Van Belle, 2013).

Gartner (2011), a renowned IT research consultant, in a survey of 1,500 Chief Information Officers (CIOs) of big corporations worldwide regarding their technology spending and growth, found that business intelligence systems have remained the number one priority in top ten technology spending for the last three years. In fact, Gartner found that spending on BI systems had been the least affected by the recent economic downturn when compared to other technology spending because of the high priority that CIOs give to business intelligence platforms. They noted that the market revenue for BI products alone was worth about $13.8 billion dollars in 2013, a seven percent increase from 2012, and is forecast to reach $17.1 billion by 2017 (Gartner Research Feb, 2013). Howson (2008) reported similar findings with regard to IT budget spending on business intelligence related technologies, which ranged from $14 to $20 billion, with growth estimates of about ten percent per year for the foreseeable future.

Indeed, given its potential, organisations are eager to implement business intelligence systems (Yeoh & Koronios, 2010; Olszak & Ziemba, 2012) and this has led to a lot of economic activity and vibrancy in the industry in order to capture markets and consolidate their position, especially among the major business intelligence software vendors such as Microsoft, SAP, MicroStrategy, SAS, Oracle and IBM (www.microsoft.com; www.sap.com; www.microstrategy.com; www.sas.com; www.oracle.com; www.ibm.com).

1.2 Problem Statement and Research Question.

However, business intelligence systems are complex and costly to implement with many cases of failures (Howson, 2008; Yeoh, 2010; Olszak & Ziemba, 2012). Firstly, it is necessary to conduct a business, functional and technical requirements analysis. The next step involves the architecture, design and build that include: the design of enterprise data warehouses for a centralised data repository, the design of multiple views and dimensions of datasets, data mining, aggregation and measurements via analytical processing cubes that continuously reflect the ever-changing business needs. Then, there is the design of a reporting and presentation format (score cards, dashboards etc.) that can instantly capture underlying meanings with visual impacts for effective and quick decision-making processes and finally, the issues of data quality and integrity, coupled with managing the whole process.

Indeed, BI implementation is a huge and challenging task that is fraught with failures at each point in the project lifecycle (Moss & Atre, 2004; Hawkins & Sellitto, 2011). Howson (2008), in a survey of companies using BI systems, found that only 24% identified their BI implementations as being successful. The study further noted that even organisations that had implemented BI systems, though enjoy some initial benefits, were yet to exploit the full potential offered by their BI solution. All of which gives rise to a number of questions in particular, why are there so many cases of BI systems implementation failure? What is different about those companies that have successfully implemented business intelligent systems? And what are the necessary and sufficient conditions for success?

Clark et al. (2007) suggest that information systems (IS) implementations fail because many organisations do not fully understand the link between the critical factors and success benefits for which the information systems were intended. They specifically stressed that a primary criterion for attaining success is that the specific IS implementation must match the problem for which it was desired. Hartono et al. (2008) investigated the critical success factors identified in major information management systems research. They defined the critical success factors as a key *"success antecedent"*, which should be carefully managed, *"if the information system is to be favourably received and the implementation is to be deemed as successful"* (Hartono et al., p.257). However their study found no specific key success antecedent that was uniform across the organisations for achieving IS implementation success. Instead, they noted that organisations must think carefully about what benefits they need most from an information system and then manage the corresponding critical success factors antecedent. Davenport and Harris (2007), and Eckerson (2012) noted that BI systems are analytical systems that are very unlike conventional transactional processing systems; they have a unique set of characteristics that apply to them. Jamaludin and Mansor (2011) stressed that BI system implementation that ignores this uniqueness is most likely to fail. All of these raised the question of which critical success factors (CSFs) are relevant to business intelligence system implementation and what are the experiences of those organisations that have successfully implemented business intelligence systems? Thus, this research is guided by the following key and subsequent research questions:

(a) What are the critical success factors for business intelligence system implementation?

- What is their level of criticality?

- What is the strength of the interrelationship between the critical success factors?

(b) What constitutes business intelligence system success?

- Which CSF relates to which BI success measure?
- To what extent do the CSFs impact the BI implementation success?

(c) How can organisations effectively implement a business intelligence system?

- Why do organisations invest in business intelligence systems?
- What does the process of BI system implementation involve and what are the major challenges?

1.3 Research Motivation

Despite the well acknowledged potential of business intelligence systems, the vibrancy of the industry, the complexities of BI system implementation and the reported failures, very few empirical studies have been conducted on the critical success factors affecting BI system implementation (Yeoh & Koronois, 2010; Olszak & Ziemba, 2012; Olszak, 2014).

Of course, there are theoretical accounts on the benefits and usage of BI technology (Davenport et al., 2007; Jourdan et al., 2008; Liebowitz, 2006; Williams et al., 2007). There are also industrial accounts or at best manuals on how to implement a software vendor's variant of a business intelligence system. However, very few empirical studies have been conducted on the critical success factors that influence business intelligence implementation (Howson 2008; Yeoh & Koronois, 2010; Harrison 2012; Olszak & Ziemba, 2012; Dawson & Van Belle, 2013; Naderinejad et al., 2014), perhaps due to its relative newness as a field of study compared to the more traditional fields, and the fact that business intelligence has been largely driven by the IT industry rather than by academia (Jourdan et al., 2008; Chio, 2012). Furthermore, little is known about the difference between business intelligence systems and traditional information management systems and there exist different views among practitioners and even researchers on how BI systems can be designed and implemented in organisations (Farrokhi1 & Pokorádi, 2012).

Historically, critical success factors have been studied extensively in information system (IS) research (Ein-Dor et al., 1978; Martin, 1982; Delean & Mclean, 1991; Grover et al., 1996; Seddon et al., 1999; Holland, 1999). DeLone and McLean (1991), who conducted one of the most frequently, cited studies in information systems research, identified variable factors for system success and characterised taxonomies such as user satisfaction, information use, information quality, system quality, individual impact and organisational impact. However, most of these earlier studies on the critical success factors of information systems were generic, and it was not until the 1990s, following the massive failure of enterprise resource planning (ERP) system implementation, that research began to investigate critical success factors specific to different types of information management systems such as ERP systems (Holland et al., 1999; Murray & Coffin, 2001; Zhang et al., 2002, Nah & Deldado, 2006), and customer relationship management systems (CRM) (Croteau & Li, 2003).

Furthermore, critical success factor studies were examined as singular, isolated phenomenon and fragmented, often depending on the researcher's perspective, and there are few empirical studies in information management systems (IMS) research that have evaluated the interrelationship between the critical success factors and/or the CSFs and information system IS implementation success (Hwang & Xu, 2008), and there are certainly none in the area of business intelligence system implementation (Yeoh, 2010; Olszak & Ziemba, 2012; Dawson & Van Belle, 2013; Naderinejad et al., 2014). Therefore, one of the motivations for this study was an attempt to bridge the gaps in the existing literature by providing an integrated perspective of the critical success factors that influence BI system implementation.

1.4 Research Aim and Objective

Hevner et al. (2004) noted that research should aim to either develop new theories and/or models to explain a phenomenon, or to verify existing theories and/or models. Nachmias and Nachmias (1996) noted that research should increase the sum of what is already known, by finding out new facts and relationships through a methodological investigative inquiry. This research has three major aims:

(1) To understand the process of business intelligence system implementation and the critical success factors relevant to it.

(2) To develop a success model to guide the process of business intelligence system implementation. Such a model is imperative given the reported failures of BI system implementation and the increasing interest from the IT industry and business.

(3) To make a unique contribution to the advancement of the theory of critical success factors, and business intelligence system implementation in particular.

Based on these major aims, this research will pursue the following key objectives:

1. Explore the critical success factors of business intelligence system implementation.
2. Access their level of criticality
3. Evaluate the strength of the relationship between the critical success factors.
4. Establish the extent to which the critical success factors impact BI implementation success.

5. Examine which critical factors relate to which BI success measure
6. Understand what drives an organisation to invest in such pioneering technology.
7. Examine the major challenges in the process of BI system implementation.
8. Propose a model to guide the process of BI system implementation.

1.5 Research Approach.

Research is a quest to examine a phenomenon in one or more ways. Research seeks explanations, comparisons, relationships, predictions and generalisations, and it also allows for further investigation (Bryman & Bell, 2006; Blaike, 2007). This research is exploratory and seeks a better understanding of the theory and practices underpinning the process of business intelligence system implementation. Phillips and Pugh (2000) define exploratory research as that undertaken when investigating a new phenomenon about which little is known, and this is particularly relevant to business intelligence system implementation (Hawkings, 2011; Chio, 2012).

The choice of the research method for this study is informed by the research objectives. The research seeks to address the questions of "what", the "level of criticality", "why" and "how", in understanding the process of BI implementation. The assessment of "what" and the "level of criticality", require measurements and necessitate the use of quantitative methods, while the "why" and "how" aspect in understanding the process of BI implementation requires inducing and making meaning and necessitates the use of qualitative methods. Therefore, a mixed methods approach that triangulates quantitative and qualitative techniques, grounded in the realist research paradigm has been adopted for this study (Yin, 1994; Bryman & Bell, 2007).

The quantitative aspect involved a survey (N=102) of key stakeholders in UK organisations that had implemented a business intelligence system to elicit their experiences regarding the key research elements and the effectiveness of the critical factors of BI implementation. The qualitative aspect was a semi-structured interview case study conducted in four organisations that had implemented a BI system to gain a deeper insight into the process and challenges of BI implementation in real-life settings, and how the critical success factors are applied. The essence of the case study was to complement the survey and strengthen the final research findings and conclusions. Bryman (1996) noted that triangulation adds an extra dimension of rigor, and research is enriched by the addition of other, different techniques to the tool basket.

1.6 Research Contribution.

This research makes significant contributions to the theory and practice of the business intelligence field in a number of ways.

From a theoretical perspective, the study of business intelligence and in particular the critical success factors (CSFs) of BI are relatively new and developing (Hawkings, 2011; Olszak & Ziemba, 2012; Dawson & Van Belle 2013; Naderinejad et al., 2014). Existing studies have focused on identifying and naming the critical factors and how they were applied in inductive case studies. This study extends existing research by exploring the relationship between the critical success factors and their precise impact on BI implementation success. It also extends current research by providing a framework on which future research on the relationships between the critical success factors of business intelligence implementation can be conducted.

From a practical business perspective, this study is of significance to organisations that are either contemplating or implementing a BI system, when faced with the problem of how best to allocate critical success factor resources, and how to identify and align the critical success factors with their BI success objectives to achieve optimal benefit from their BI implementation initiative. From a project management perspective, it also provides some prescriptive guidelines to companies currently implementing BI projects when addressing issues of CSFs interdependence and how to manage risk and increase the chances of the BI project's success.

Finally, this study is an attempt to bridge theory and practice, by applying a theoretical understanding of critical success factors to the contemporary practical problem of business intelligence system implementation based on the experiences of high-profile best practice organisations. The integrated perspective adopted in examining the CSFs provides a unique insight into the understanding and practice of business intelligence implementation, and also offers a holistic picture of the process, which has been found to be lacking and noted as being responsible for many of the implementation failures (Hawking & Sellitto, 2011).

1.7 Scope of Study

This study is grounded on the theory of critical success factors and information management systems. Its focus is on how a set of critical success factors influence business intelligence system implementation, a unique type of information management system. The study is neutral in terms of BI software and vendors' technical platforms; rather, it aims to provide an independent and well-articulated perspective of an enterprise's business intelligence system implementation. The study draw on reviews of similar IMS research, coupled with empirical data from the survey results and interview case studies of UK organisations that have implemented business intelligence systems.

1.8 Chapter Arrangement.

This research comprises eight major chapters; see Figure (1.1) for the research process workflow.

Chapter One provides the introduction and background to the study; this includes the research questions, the aims and objectives, and the research motivation. The chapter also introduces the research methodology and contributions.

Chapter Two is the first part of the literature review and provides an overview of the phenomenon, including: evolutions, definitions, perceptions, the BI system architecture, why BI, the future of business intelligence and the BI project life cycle. These constructs informed the research and provided the theoretical foundation for the study.

Chapter Three is the second part of the literature review and discusses the theories, models, and arguments on critical success factors, studies on CSFs of business intelligence system implementation, and an evaluation and critique. This is followed by the development of the research conceptual framework.

Chapter Four addresses the research methodology and design, including the reason for the choice of methods, and a detailed description of the research techniques for data collection and analysis for both the quantitative and qualitative investigations, including issues of research ethics and quality.

Chapter Five presents an exposition and analysis of the survey data collected, (N=102).

Chapter Six presents an exposition and analysis of the interview case study data collected from the four participating UK organisations.

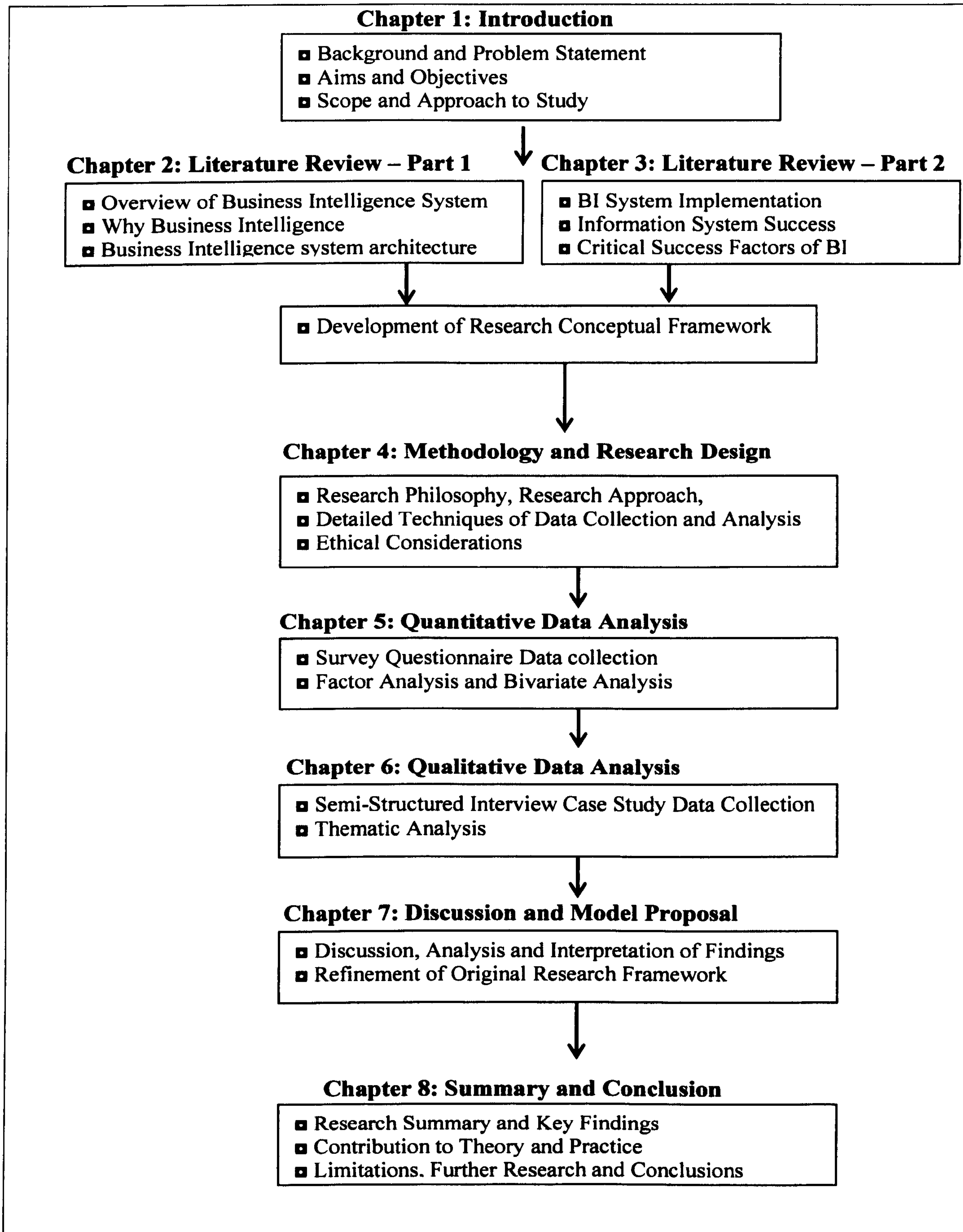
Chapter Seven presents the discussion, interpretation and triangulation of both the research findings in line with the research objective and the literature, followed by the proposed success model for business intelligence system implementation.

Chapter Eight summarises the entire research study including: the key findings, the contributions to theory and business practice, the limitations of the study, potential directions for future research and the conclusion.

1.9 Summary.

This chapter laid the foundation for the development of this research. It firstly provided an introduction and background to the object of study. Thereafter it discussed the research problem and questions. This was followed by a discussion of the motivation for the study, including the study's aims and objectives. The methodology adopted for this study was then briefly discussed, followed by the scope of study, and an outline of the research thesis. The next chapter provides a review of the relevant literature upon which this thesis is built.

Figure 1.1: Research Process Workflow



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CHAPTER TWO: LITERATURE REVIEW PART I

OVERVIEW OF BUSINESS INTELLIGECE

2.1. Introduction

To understand the process of business intelligence system implementation, it is important to firstly explore the phenomenon of business intelligence. Essentially, what is business intelligence? Why do organisations implement business intelligence systems? How does one evaluate the benefits of business intelligence? What are the components of a business intelligence system? What differentiates business intelligence from other conventional information management systems? And finally, what is the future of business intelligence and what is the process involved in business intelligence system implementation? These constructs are explored in this chapter (the first part of the literature review) in order to familiarise the reader with the main concepts relevant to the phenomenon of business intelligence implementation.

2.2. Literature Review Methodology.

This study adopted a systematic literature review, described by Denyer and Transfield (2006), as explicitly stating the criteria and procedure for selecting, evaluating and synthesising the literature for a study (Levy & Ellis, 2006). The search started with online journal publishers such as: ISI Web of Knowledge, ProQuest, Elsevier (ScienceDirect), INFORMS, JSTOR, LEA Journals, ACM (Digital Lib), IEEE (CompSoc & Xplore) and Thomson (G. Bus, OneFile). One of the criteria used was to search by title, based on these key words: "success/succeed" and or "critical success factors/issues" along with the term "business intelligence/BI". The review undertook a backwards and forwards search of most cited and referenced articles, including articles from leading authorities in the field of business intelligence. The initial search revealed less than ten empirical works on CSF studies of business intelligence. Given this, the study reviewed journal articles on critical success studies in other related fields of IMS, such as customer relationship management systems (CRM), enterprise relationship planning systems (ERP), decision support systems (DSS), and knowledge management systems (KM). However, the criterion used when selecting studies from other areas of information management systems research was that they had to come from only the top fifty MIS journals as ranked by IS-World (Levy & Ellis, 2006) and quality papers from ranked Information Systems (IS) conference papers and proceedings (Hardgrave & Walstrom, 1997), see journal rankings; Appendix 1 and 2.

2.3. The construct of Business Intelligence (BI)

2.3.1 Evolution of Business Intelligence

The concept of business intelligence in itself is not new, and has been an integral part of the well established field of business studies for a number of years. BI addresses the same old managerial problem of how to analyse complex business information in order to make better decisions. Gilad and Gilad (1986, p.53) noted that organisations have always *"collected information about their competitors since the dawn of capitalism. The real revolution is in the effort to institutionalize intelligence activities"*.

Business intelligence systems evolved out of the limitations of decision support systems (DSS) (Olszak & Ziemba, 2007; Olszak, 2014). Early information management systems were designed to automate the process of collecting, storing and processing data, and providing basic information reporting (Gibson et al., 2004; Olszak and Ziemba, 2007). Zuboff (1988) argued that technology should go beyound informing, to *"empowering ordinary working people with overall knowledge about their business operations..., making them capable of* *critical and collaborative judgments...*" (p.243). Davenport and Harris (2007) indicated that contemporary information systems could not identify the impact of data on a business in an understandable and applicable way, and that reporting functionalities were inflexible and limited. Attempts to improve data analysis and reporting functionality led to the emergence of a new type of application system, termed decision support systems (DSS) (Barki et al., 1985; Olszak & Ziemba, 2004). However, DSS were typically business function specific (Arnott et al., 2008), whereby the underlying data were specific to a business unit and the user interfaces were customised for that specific business activity. A later variant called executive support system (ESS) and executive information systems (EIS) did not meet decision makers' expectations either. Olszak and Ziemba (2007) noted that DSS, ESS and EIS systems could not handle the integration of different, dispersed and heterogenic data sources, and were incapable of sufficient data discovery and revealing interdependencies. This lack of integration hindered business understanding and effective decision-making processes, and an attempt to overcome these limitations led to the emergence of data warehousing systems (Inmon, 1992; Davenport, 1998;Bui, 2000). Early data warehouses were large, centralised, historic data repositories, which were often built without clearly defined business rules and performed only standard reporting. They lacked the tools to undertake in-dept data analysis and mining (Kimball et al., 1998; Moss & Atre, 2003).

Evolving from this was a class of specific analytical applications designed specifically to interogate, mine and perform predictive analysis on stored data and take advantage of the data warehouses, called business intelligence systems (Olszak & Ziemba, 2007; Rajesh 2008). The figure below illustrates the historical deveopment of the modern BI system.

Figure 2.1: Business Intelligence Development

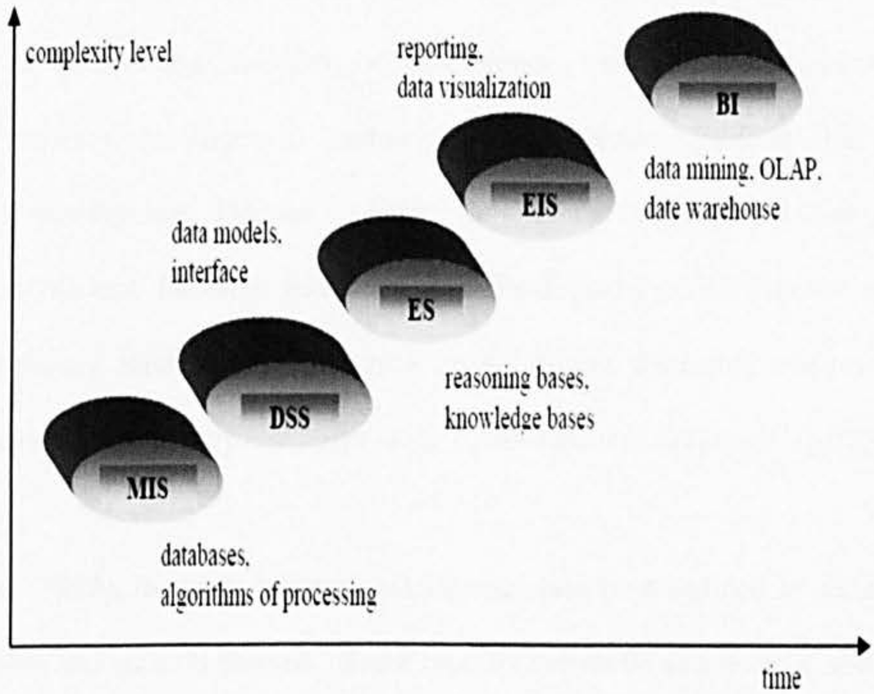


Figure 1. Development of management information systems.

Source: (Olszak, & Ziemba, 2004).

2.3.2 Definitions and Schools of Thoughts

According to Yeoh et al. (2009), the term business intelligence (BI) was first used in an IBM article entitled "A Business Intelligence System" by Luhn in 1958.

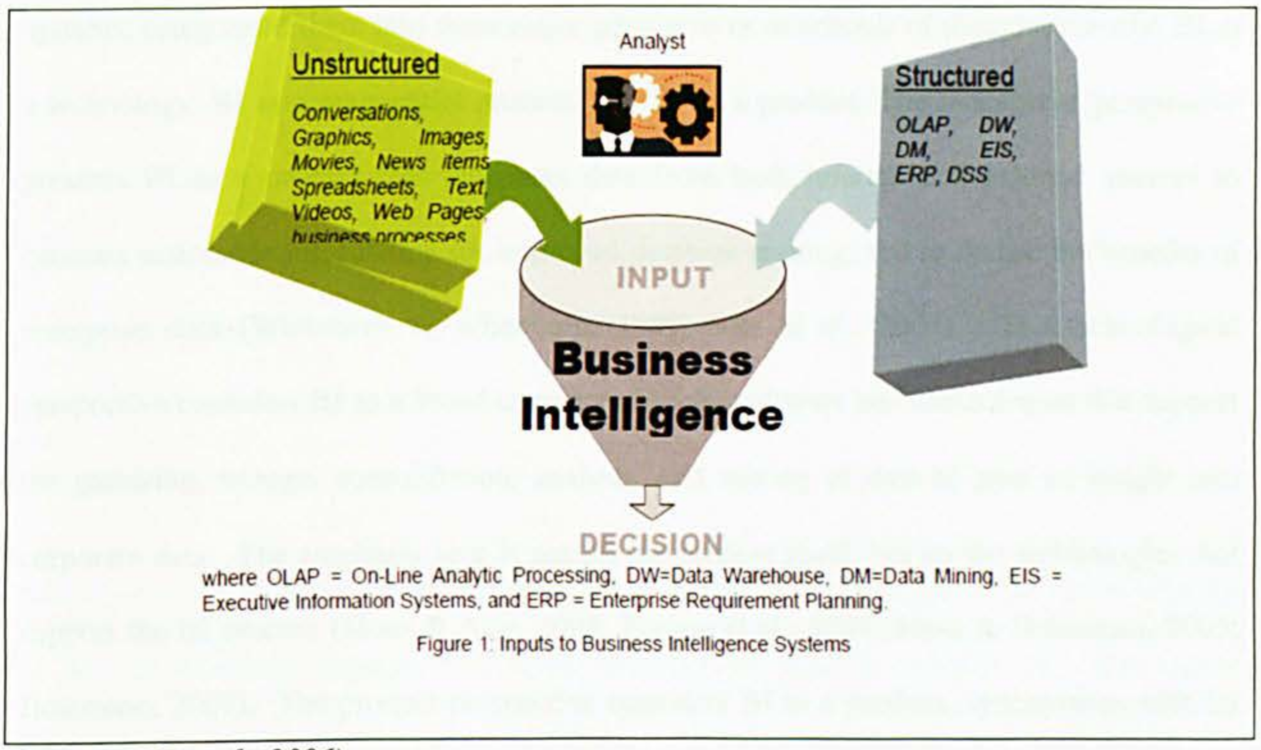
In Luhn's words, "*Business is a collection of activities carried on for whatever purpose, be it science, technology, commerce, industry, law, government, defence, et cetera. The communication facility serving the conduct of a business (in the broad sense) may be referred to as an intelligence system*" (p.314). The notion of intelligence is also defined here, in a more general sense, as "*the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired Goal*" (Luhn, 1958, p.314).

However, the term only began to draw the attention of researchers in the 1980s as they focussed on activities within which information about general business competitiveness were gathered and analysed, (Ghoshal & Kim, 1986; Tyson, 1986; Dresner, 1989). Tyson (1986) defined BI as comprising varieties of intelligence: customer intelligence, competitor intelligence, market intelligence, technology intelligence, product intelligence and environmental intelligence. Dresner (1989) of Gartner research and one of the major proponents of modern business intelligence defined business intelligence as, "*a broad category of software solutions for gathering, consolidating, analyzing and providing access to data in a way that lets enterprise users make better business decisions*" (p.323).

Since Dresner (1988), the term business intelligence had been defined in different ways by different authors and is multi-faceted. Some broadly define BI as a holistic and sophisticated approach for cross-examining organisational data to support decision-making (Alter, 2004), while others defined BI from a more technical viewpoint (White, 2004). Davies (2002 p.313) defined business intelligence as *"the acquisition, interpretation, collation, assessment, and exploitation of information"*. Evelson (2007) defined BI as *"a set of processes and technologies that transform raw, meaningless data into useful and actionable information"* (p. 43). Vitt et al. (2002) saw BI as more of a management philosophy with an enabling technology. They view BI as an *"approach to management that allows an organization to define what information is useful and relevant to its corporate decision making"* (Vitt, 2002, p.13). To them, BI is an attitude towards problem solving, rational management and business strategy.

Negash (2006) saw business intelligence as the integration of structured and unstructured data for a more effective decision-making process, illustrated in Figure 2.1 below. Table 2.1 presents other definitions of business intelligence.

Figure 2.2: Business Intelligence Structured and Unstructured Data



Source: (Negash, 2006)

Table 2.1: Definitions of Business Intelligence.

Authors	Definitions
Moss and Atre (2004)	Processes, technologies, and tools needed to turn data into information, information into knowledge and then knowledge into plans that drive profitable business actions
Williams & Williams 2007	Business information and business analyses within the context of key business processes that lead to decisions and actions and that result in improved business performance
Ranjan (2008)	The conscious methodical transformation of data from any and all data sources into new forms to provide information that is business-driven and results-oriented.
Turban et.al (2011)	A discipline that combines services, applications and technology to gather, manage, and analyse data, transforming it into usable information to develop the insight and understanding needed to make informed decisions
Olbrich et al. (2012)	BI is more than just a collection of tools and techniques, it is also concerned with the effective deployment of organisational practices, processes, and technology to create a knowledge base that supports the organization
Olszak 2014	An integrated set of tools, technologies and software products that are used to collect heterogenic data from dispersed sources and then to integrate and analyse data to make them commonly available

Source: Compiled from (Yeoh et al., 2009; Olbrich et al., 2012; Olszak, 2014)

Yeoh et al. (2009), in a review of various definitions and applications of business intelligence systems, categorised them into three major perspectives or schools of thought, namely: BI as a technology, BI as a managerial process, and BI as a product. The managerial perspective presents BI as a process that integrates data from both internal and external sources to generate actionable information for improved decision-making, and to realise the benefits of enterprise data (Whitehorn & Whitehorn, 1999; Vitt et al., 2002). The technological perspective considers BI as a broad category of tools, software and technologies that support the gathering, storage, consolidation, analysis, and mining of data to gain an insight into corporate data. The emphasis here is not on the process itself, but on the technologies that support the BI process (Moss & Atre, 2003; Turban et al., 2007; Moss & Hoberman, 2005; Hostmann, 2007). The product perspective considers BI as a product, synonymous with BI vendors' software offerings on business intelligence tools and functionalities, for data extraction, transformation, integration, statistical analysis, data mining and reporting. Business intelligence is conceptualised here as Microsoft BI, SAS analytics; Cognos Reporting, SAP Business Object Data Integrator etc. (Chang 2006; Gangadharan & Swami 2004; Turban et al., 2007). It must be mentioned however that the definitions given by some of these authors span across all three categories.

Oszalk (2014) discussed the practical value perspective of business intelligence as: organisational, technical, strategic, tactical and operational. The organisational perspective considers BI as a holistic and sophisticated approach to cross-organisational decision-making process by transferring data into information and knowledge (Moss and Atre, 2004; Isik, 2011; Gray, 2006). The technical perspective considers BI as an "*integrated set of tools, technologies and software products that are used to collect heterogenic data from dispersed sources and then to integrate and analyse data to make them commonly available*" Olszak

2014, p1104. The strategic perspective considers BI as enabling organisations to set precise objectives and allowing for the realisation of the established objectives by examining performance and different comparative reports. Closely related is the tactical perspective, which provides in-depth analysis for decision-making, for instance on sales, marketing, finance, and capital management etc. At the wider operational level, BI is seen as enabling the monitoring of key performance indicators of departments' ongoing operations, including their up-to-date financial position, and co-operation with suppliers and customers (Olszak, & Ziemba, 2006).

Historically and within the major economies, the term is used differently. While the concept of BI was relatively common in Europe, business intelligence activities are often called competitive intelligence or market intelligence in North America (Combs and Moorhead, 1992; Gilad, 1996). Gilad used competitive intelligence as an alternative term for business intelligence, whereas Pirttil (2000), Choo (2002) and Weiss (2003) consider competitive intelligence as part of business intelligence. In fact, Chen et.al (2012) noted the term intelligence only became universally popular in the IT community in the 1990s.

As a discipline, some researchers perceive BI as a subset of knowledge management (KM), (Arnott et al., 2008); while others are of the opinion that KM is part of BI (Negash et al., 2003; Rajesh, 2008). Gangadharan and Swamy (2004) consider BI as technically much broader, potentially encompassing knowledge management, enterprise resource planning, decision-support systems and data mining (Olszak and Ziemba, 2007). Harris (2007), in the Havard Business School Press noted that *"analytics are a subject of what has become business intelligence"* (p.7). More recently and with the evolving of big data analytics, practitioners and researchers have also wondered whether business intelligence and big data analytics are different or the same. This is perhaps due to the fact that big data refers mostly to unstructured data, while traditional business intelligence deals with semi-structured and structured data. However Chen et al. (2012) noted that big data is related to business intelligence and a well-implemented business intelligence solution should encompass both.

From the definitions and discussions above, it is clear that the concept of business intelligence (BI) is multifaceted and perceived as a business philosophy, a management process, a technology, a product, a discipline, a holistic approach to problem solving, a strategy, a tactic and an operational process. This often happens with commonly used terms and more so, in an emerging discipline where everyone attaches slightly different meaning, depending on their needs and perspectives (Eckerson, 2012; Olszak & Ziemba, 2012; Olszak, 2014). However, all of the BI definitions and perceptions share some common constructs and focus. Firstly, they include the concepts of data gathering and warehousing, data mining and analysis, data reporting and visualisation. Although, as Everson (2007) stated, these technologies by themselves do not constitute business intelligence; rather BI is an integration of all of the above components. Secondly, BI aims to transform data into information, and information into knowledge that aid effective decision-making processes and problem-solving efforts (Negash et al., 2006; Rajesh, 2008; Lönnqvist & Pirttimäki, 2006: Eckerson, 2007). Thirdly, BI subsumes the more specific intelligence activities like competitive intelligence, customer intelligence, product intelligence and others.

Combining the various discussions above, this study defines BI as a business management process that utilises technology to gather, integrate, analyse and provide comprehensive knowledge on organisations' operations to enable effective and better business decisions.

2.3.3: Business Intelligence System.

The business intelligence system is used in this study as an integrated enterprise information management system that provides the capability for data warehousing, data mining, analysis, and data presentation (Atos & Moss, 2004; Evelson, 2007). In this definition, data warehousing is a subsystem of a business intelligence system (Moss & Atre, 2004). More often than not, the terms 'business intelligence' and 'data warehouse' have been used interchangeably. However, Olszak and Ziemba (2007) noted in the evolution of business intelligence, that data warehousing is just one component of delivering business intelligence. Another component for example is the customer relation management system. Evelson (2008), who sneered at the interchangeable use of the term 'business intelligence' with reporting, stressed that analytics and reporting, often referred to as the presentation layer of the BI system, are just a subset of the entire business intelligence architecture stack. Accordingly, Olszak & Ziemba (2007) noted that the business intelligence systems provides a complete information management framework for organisations seeking intelligent exploration, integration, aggregation, data mining and multidimensional analysis, and reporting of different sources of structured and unstructured data, whether from statistical, financial, sales or other miscellaneous databases.

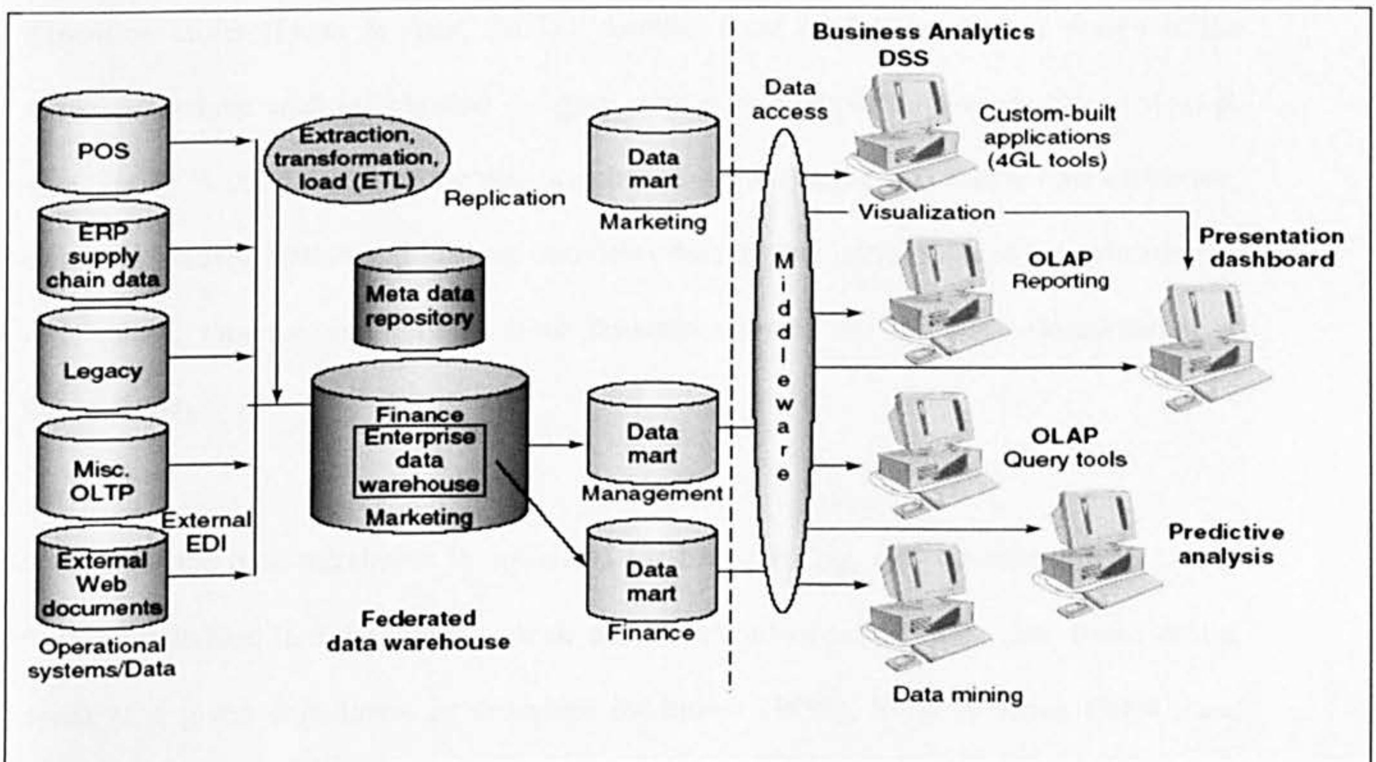
Business intelligence system implementation is used in this study as an end-to-end enterprise process of system initiation, through to feasibility, analysis and design, development, conversion, deployment, training and maintenance of the BI system (Moss & Atre, 2003).

2.4 Business Intelligence System Architecture

To successfully implement a business intelligence system, one must understand the components and technologies that constitute a typical business intelligence system.

The business intelligence architecture comprises three main distinct but complementary data management layers: the data warehouse layer, data analysis and mining, and the data visualisation layer (Olszak & Ziemba, 2007; Davenport et al., 2010). Data extraction, transformation and loading (ETL), as well as cleansing and filtering are aided by the ETL tools (Azvine & Nauck, 2005; Eckerson, 2007). Data types handled by the ETL tools can include structured (e.g.: relational), semi-structured (e.g.: XML) and unstructured (e.g.: flat files, Web files, documents, etc.), and different BI software vendors have their own ETL tools. Figure 2.3 shows typical business intelligence system architecture and its components.

Figure 2.3: Business Intelligence Architecture



Source: (Turban et al., 2007)

2.4.1 Data Warehouse Layer

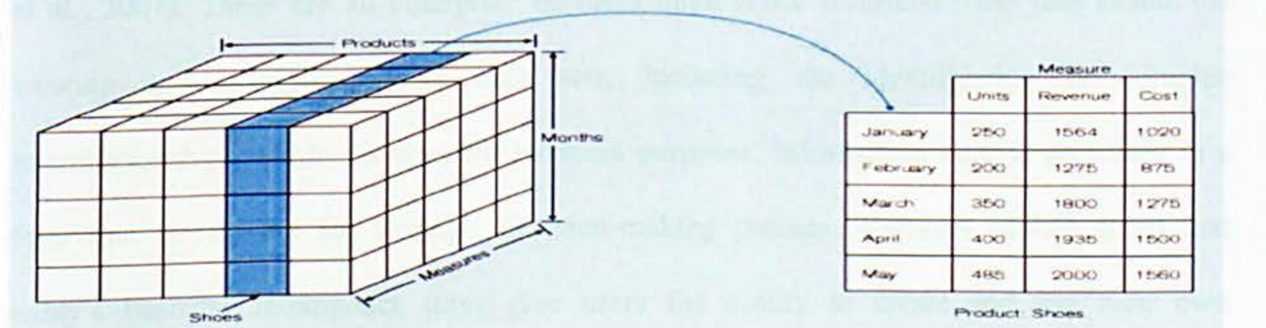
The data warehouse provides the centralised repository for historical, operational, aggregated and analysed data, and is considered the most important layer of the BI architecture. Data sources can originate from internal operational systems such as enterprise resource planning systems (ERPs), customer relationship management systems (CRMs), human resource systems, knowledge management systems, and supply chain applications, including external sources such as market research companies and the internet (Watson & Wixom, 2001; Turban et al., 2007; Eckerson, 2012). Data in the warehouse are stored thematically in fact and dimension tables (Moss & Atre, 2003; Olszak & Ziemba, 2007). The fact tables hold broad-based reference information, while the dimension tables hold hierarchically referenced data, necessary for making decisions with respect to a hierarchy, business category or an area or region. The logical design of the data warehouse may take the form of a star schema, or constellation, which is typified by the star central table surrounded by the referenced dimension tables (Moss & Atre, 2003). Another form of data warehouse design is the snowflake, where each information category may have multiple dimension tables (Moss & Atre, 2003). A crucial part of the data warehouse is the staging area where data extraction, cleansing, transformation and loading, and other data quality issues such as the validation of data values, schemas and formats from disparate sources are resolved (Gangadharan & Swani, 2004).

By design, the data warehouse is optimised for fast querying, and warehouse data can be further subdivided into data marts, which are collections of subject area data, based on the needs of a given department as described by Inmon (1999), Moss & Artos (2004), and Evelson (2007). These subject area data marts can be finance, marketing, sales, human resource data and others. Inmon (2002) noted that there are different opinions as to whether it is better to build more data marts instead of a unified data warehouse. The data from a data mart are usually aggregated to a certain level. Organisations can extract data directly from either a data mart or the main data warehouse for analysis and reporting purposes. A typical large data warehouse holds terabytes of data, whereas smaller domains or business unit data marts are often in the range of tens of gigabytes. In recent years, with the emergence of Cloud computing, new technologies such as cloud data warehouses are being introduced into the business intelligence data warehouse architecture (Eckerson, 2012).

2.4.2 Data Mining and Analysis Layer

The next important layer of the business intelligence architecture is where online analytical processing (OLAP) and data mining are undertaken. The OLAP tool provides multi-dimensional patterns and summarised views of data using statistical and analytical modelling techniques built within the tool. OLAP helps to answer the question of "what if" analysis and helps to forecast and interpret data. Moss and Atre (2003) noted that the OLAP engine acts as a query generator that provides users with the ability to explore and analyse multidimensional sets of data at the same time, which traditional relational database engines would find difficult to achieve. Decision makers can use an OLAP engine to see different perspectives of the same data in what is called "slicing and dicing" of the data into various dimensions (see Figure 2.4). These can then be drilled down into the source data or roll-up to aggregate levels. Data in the OLAP are stored in the form of cubes. An OLAP cube is a subset of data that allows intuitive parameter based navigation of very large datasets (Cheng et al., 2005).

Figure 2.4: Slicing of BI Data Cube



Source: (Hoffer et al., 2002)

Another important component in this layer is the data mining tool, which Eckerson (2007; 2012) refers to as knowledge discovery and predictive analysis. The data mining process makes it possible to discover hidden trends and patterns, identify relationships and rules, and draw inferences that are not explicit in a large database, using statistical modelling techniques and algorithms provided by the BI solution (Jourdan et al., 2008; Datta, 2008).

Data mining tools can be applied directly to data warehouses and or multidimensional data sets in the OLAP, a process referred to as OLAM (online analytical data mining). In recent years, with the emergence of cloud computing, web mining techniques, opinion mining techniques, mobile mining techniques and semantic processing, and data streaming techniques have been applied in building business intelligence systems (Eckerson, 2012). These techniques focus on the processing of unstructured, quasi-structured and semi-structured data that originates mainly from the internet and social media (Marozzoa et al., 2011; Oszalk, 2014; Chang, 2014).

2.4.3 Data Visualisation Layer

The data visualisation component provides visual tools for ad hoc reporting and customised graphical and multimedia interfaces, presented in the form of BI dashboards, BI scorecards, BI key performance indicators (KPIs) and business performance management (BPM) (Turban et al., 2007). These are all enterprise business intelligence front-end tools that enable the viewing and manipulation of data sets, including the identification of complex interrelationships within the data for business purposes. Information here is presented in a form that is relevant for strategic decision-making process. Karbhari (2006) noted that today's business intelligence tools give users the ability to create and use their own dashboards, control the analysis and generate their own reports through a standard browser interface, instead of having to wait for someone supposedly more technical, as was the case a few years ago. Bologa et al. (2008) emphasised the efficiency of developing business intelligence portals that enable multiple forms of data visualisation. The main purpose is to integrate data from different applications and services used by employees, partners, suppliers and clients, which can then be offered as a service to the business community (Lungu et al., 2009). Compared with traditional BI presentation architecture, the web-centric and service-oriented paradigm has the benefit of sharing information with a wider audience in a much simpler and cheaper manner (Wu et al., 2007). In recent years, with the advent of cloud computing, mobile business intelligence using tablets, smartphones, laptop computers and other mobile devices is incorporated into the BI visualisation techniques (Marozzoa et al., 2011; Oszalk, 2014; Chang, 2014).

Eckerson (2012), in depicting the next-generation of BI architecture and analysis (see Figure 2.5), proposed a model that should give more power to users and greater options to access, and mix semi-structured and unstructured data in "sand boxes" that fully integrate relational and non-relational data. He pointed out that this could be achieved using advanced data mining techniques like Hadoop[1], NoSQL[2] and Mapreduce,[3] which do not conform to the constraints of dimensional database modelling and normalisation rules.

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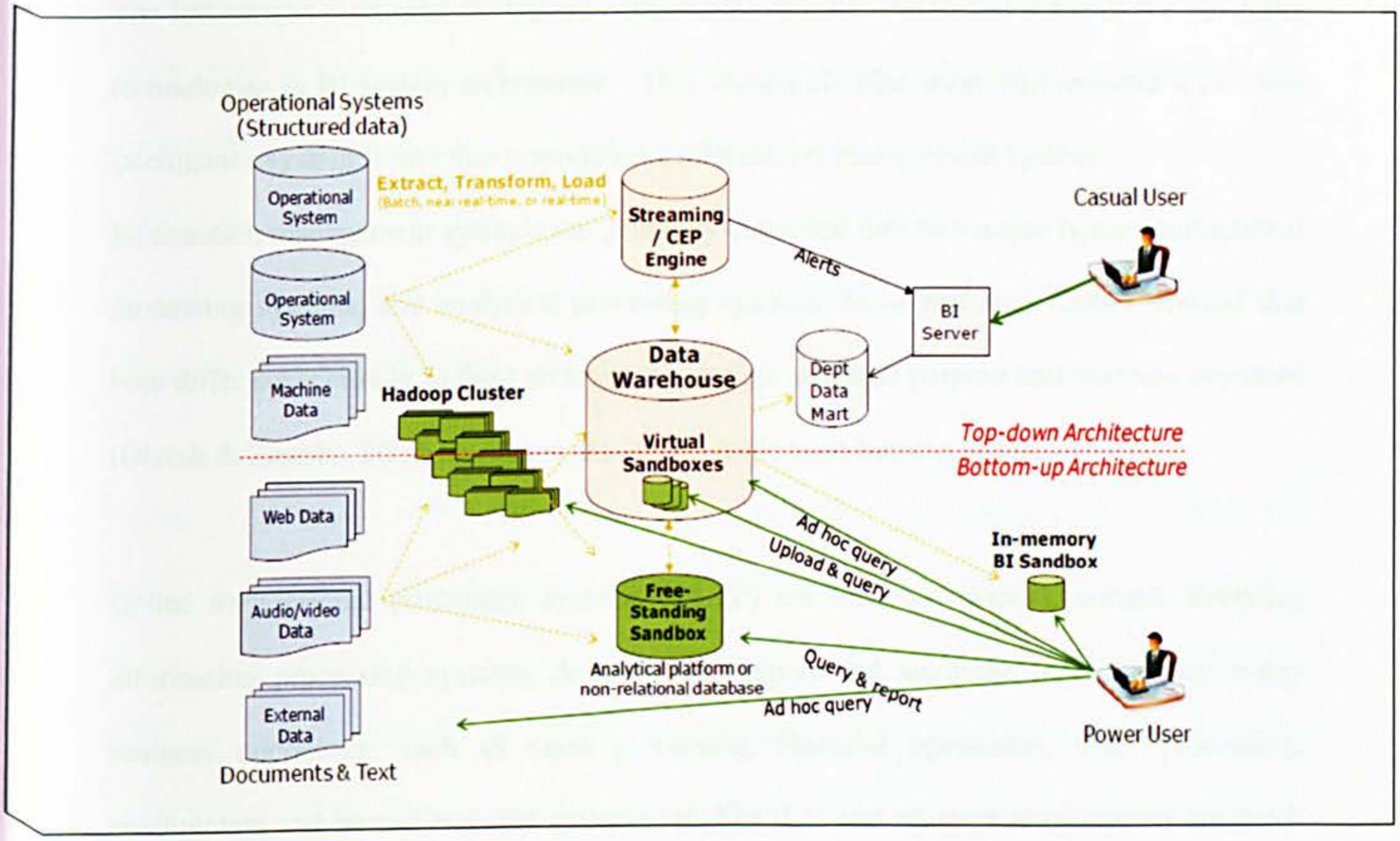
[1] Hadoop is an open-source software framework with sets of algorithms for storing, processing and retrieving very large data sets (Big Data) in distributed clusters of commodity hardware (Paul Zikopoulos et al., 2014; EMC Education Services (2014); ISBN (9781118876220)

[2] A NoSQL database provides a mechanism for data storage and retrieval that is not modelled on a standard relational tabular database format, and is particularly suitable for semi-structured and unstructured data (Adam & Mattson, 2010; Grolinger et al., 2013)

[3] MapReduce is a programming framework for parallel and efficient large-scale data processing now widely used in Cloud computing environments, was first presented by Google in 2004 (Marozzo et al., 2011)

Figure 2.5: New BI Architecture



Source: Eckerson 2012

In the figure, the top half represents the typical data warehousing architecture that primarily delivers interactive reports and dashboards to normal BI users with some complex event processing (CEP), which is new. The bottom half of the diagram depicts a more complex analytical architecture with analytical sandboxes of mixed data types. This next generation of BI architecture Eckerson (2012) noted offers a more effective technique for processing large volumes of unstructured and semi-structured data in parallel environments, compared to traditional BI implementation platforms. Secondly, it better accommodates the needs of business analysts and data scientists, making them fully-fledged members of the corporate BI ecosystem.

2.5 Business Intelligence and Conventional Information Systems.

The last section discussed the typical components of a BI system and some of the emerging technologies in BI system architecture. This section clarifies what differentiates a business intelligence system from other conventional information management systems.

Information management systems are generally classified into two major types: transactional processing systems, and analytical processing systems. Moss and Atre (2004) stressed that both differ substantially in their architecture, design, strategic purpose and business objective (Olszak & Ziemba, 2007; Turban et al., 2007; Hawking & Sellitto, 2010).

Online transactional processing systems (OLTP) are the conventional, normal, everyday information processing systems, designed to support and automate repetitive day-to-day business operations, such as sales processing, financial operations, order processing, procurement and human resource systems etc. The data and resource requirements are much smaller and typical operations are frequent but small data reads and writes (Datta & Thomas, 1999; Power, 2002). These are standalone systems designed to support operational business tasks and processing large numbers of corporate transactions (Turban et al., 2007). However, they are not designed to provide predictive analysis and do not include strategic enterprise-level planning or cross-functional business intelligence unit analysis (Moss & Atre, 2003).

Online analytical processing (OLAP) is a typical business intelligence system, designed to support predictive analysis and decision-making and facilitate broader management (Power 2002). OLAP cut across individual applications and business units. The data in OLAP are aggregated from other functional areas of the business like finance, marketing, human resources etc. Their purpose is to integrate and provide analysis from holistic or different perspectives of a company's operations. Data are presented in a rich visualisation format to support efficient and faster decision-making processes (Gray, 2003; Turban et al., 2007). OLAP data are normally large, from disparate systems and come with the challenge of data aggregation and standardisation. The technical infrastructure resource requirements are normally very extensive given the volume of data that has to be processed, and the operations can be intensive (Atre & Moss, 2003). Olszak and Ziemba (2007) noted that a well-designed BI system can support decision-making across all functional and hierarchical levels of management and stakeholders in a wider range of organisations.

In terms of technical architecture design, a conventional OLTP system will commonly use relational data modelling techniques that enforce database normalisation rules (Codd & Boyce, 1974) consisting of many tables with a few columns with minimum redundancy, which are most effective for data querying. Eckerson (2003) noted that relational data design enforces a business process structure that does not change regularly. On the other hand, business intelligence OLAP systems use dimensional data model design techniques that enforce less database normalisation rules, involving fewer tables but with many columns (Goede, 2001; Moss & Atre, 2003), which enables greater reporting and allows needs to change dynamically to meet the ever-changing business requirements. Powet (2002) asserted that an OLAP based BI system aims at enhancing the effectiveness of business decision-making rather than increasing efficiency in processing transactional data.

Given the uniqueness of and differences between the analytical (OLAP) based BI system and transactional processing based (OLTP) systems, most organisations implement these two systems in parallel for two different purposes. While there are successful cases of OLTP transactional system implementation because they are generally smaller and department function specific systems, the knowledge required to build conventional systems is not necessarily adequate to successfully implement an enterprise OLAP based BI system. Moss and Atre (2003) noted that OLAP systems require a more cross-functional, evolutionary implementation approach rather than a 'big bang' approach (Arnott, 2004).

The table below summarises the differences between conventional transactional process (OLTP) systems, and analytical processing (OLAP) BI systems.

Table 2.2: Conventional (OLTP) and Business Intelligence (OLAP) systems

Characteristics or Attributes	**Transactional OLTP (conventional) Systems**	**Analytical OLAP Business Intelligence Systems**
Primary Purpose	To support routine, every day business activities.	To support tactical, strategic and managerial decision and planning by providing right information and new insight
Key features	Transactional processing activities	Analytical processing activities
Data State	Represent current state of business data	Represent historic, point-in-time, snapshot and predictions, summarised, derived values.
Data Access type	High frequent data read\write, update and delete activities	Low to medium frequency, mostly data read activities
Primary Users	Operational staffs such as sales persons, admin staffs, front line workers etc.	Executives, Managers, business analyst, knowledge workers
Scope of Usage	Well defined, planned simple updates	Broad, ad hoc, complex queries and aggregation
Design goal	Performance throughput, availability, optimised for transactions	Ease of access, flexibility and use; Optimised for complex queries
Type of data queries	Short Simple queries involving few records in tens, hundreds.	Long, complex, longer queries involving many records in thousands, millions.
Database Management design	Relational database design Normalised databases, application oriented	De-normalised database design, Multidimensional database design, data warehouse, data mining, cubes, Star/Snow flake schema, subject oriented
Data Focus	Small incremental data input\output	Large sequential data input\output
Database Management Operations	Fewer Indexes/harsh on primary keys	Lots of scan
Project Implementation approach	Implemented as standalone separate, function based systems	Implemented as an integration of other systems, and part of a business evolutionary process

Source Own: Derived from (Hoofer et al., 2002; Power, 2002; Atre & Moss, 2004; Olszak & Ziemba, 2007; Turban et al.; 2007).

2.6. Why Business Intelligence System?

If all business data were available in the form and at the time that organisations wanted them, then there would be no need for business intelligence systems (Whitehorn & Whitehorn, 1999; Moss & Atre, 2003; Williams & Williams, 2007; Olszak &Ziemba, 2012; Ashrafi et al., 2014). However, business data are often fragmented, incomplete and not readily available in a manner that can be used effectively, especially where organisations have a number of heterogeneous systems. To overcome this issue, data from a variety of sources needs to be turned into information that can be used consistently across divisions and business units. Hawking and Sellitto (2011) indicated that the key to unlocking and realising the potential of enterprise data lies with implementing an enterprise information strategy based on business intelligence (Biere, 2003; Jaiswal & Mital, 2004; Browning et al., 2007).

Budhwar (2007), in making the case for business intelligence, noted that as organisations such as banks, telecommunications, retail and insurance grow and expand the numbers of customers can increasingly turn into millions. To understand and keep track of patterns, growth segments, market potential and changes in customers' behaviour, including forecasting and creating strategies from a massive amount of data from multiple departments, it is essential to have an analysis system that is department independent. Azvine (2007) noted that BI can help an organisation to manage risk by monitoring and leveraging the operational and financial health of the organisation through key performance indicators (KPIs), alerts and dashboards (Williams & Williams, 2007; Ziemba, 2007).

Negash (2004) noted that BI assists in converting complex information into effective decisions. He noted that information requirements differ for types of decision- making processes, and levels of managerial responsibility. He stressed that it is important that information is appropriately communicated in the right manner to different decision-making categories, be they strategic, managerial and/or tactical decisions. Strategic decision-making may involve defining a long-term vision, roadmaps and policies and may be undertaken by senior managers and analysts. Tactical decision-making may include planning and management and is usually undertaken by middle management, while operational decisions relate to processes and control and are undertaken by supervisory teams. Olszak and Ziemba's (2007) succinctly expressed in their model, the role of BI in decision-making processes (see Figure 2.5). Their model illustrates how BI helps to transform raw data into information, then to knowledge, and to effective decisions, which leads to establishing new cooperation, acquiring new customers, creating new markets, offering new products and services, improvements in competitiveness and other fundamental changes in the way organisations operate (Chaudhary, 2004; Olszak, & Ziemba, 2004; Reinschmidt & Francoise, 2002).

Figure 2.6: Role of BI in Decision-making

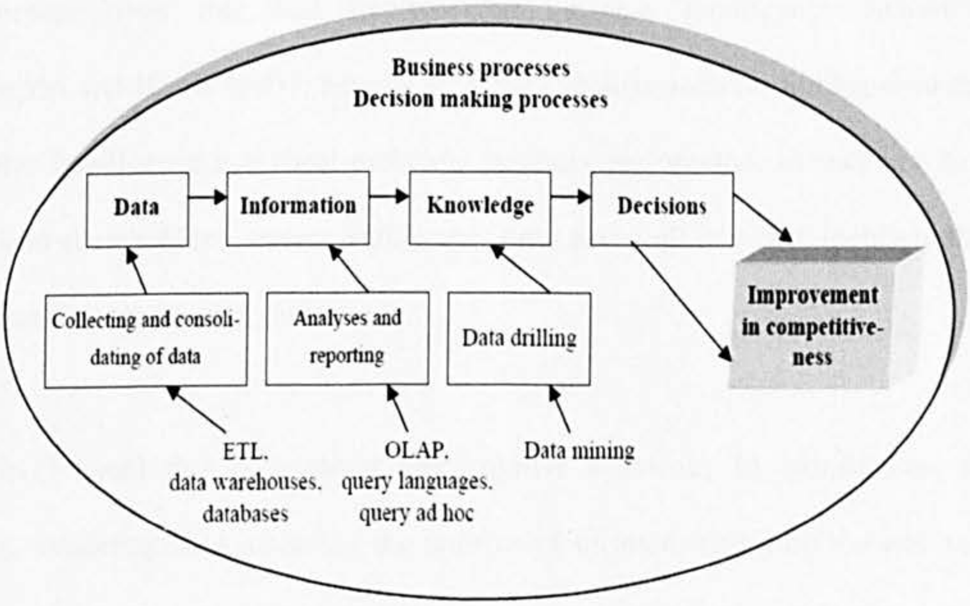


Figure 2: The role of BI systems in decision making.

Source: (Olszak & Ziemba, 2007)

Browning et al. (2007) noted that firms are interested in BI systems as a means of integrating their information sources. They opined that most organisations have made major investments in enterprise resource planning (ERP) systems, supply chain management systems (SCM) and customer relationship management (CRM) systems over the last decade. However, they are still struggling to achieve competitive advantage. Browning et al. (2007) indicated that the move towards BI systems is thus a reflection of organisations' desire to maximise their data investment and usage. Jayanthi Ranjan (2008), in expressing a similar view, argued that a successful BI ties business and information technology together to help enterprises manage and integrate on-going investments, allocate resources, prioritise projects and minimise risk.

Davenport and Harris (2007) indicate that business intelligence helps organisations gain competitive advantage, select profitable markets to enter, attract the right customers, and derive prices in accordance with risk, as well as helping to reduce the cost and severity of claims. In a reported secondary industry study of more than 450 executives in 371 large and medium sized organisations that had implemented business intelligence analytical capabilities, Davenport and Harris (2007) noted a strikingly positive relationship between the adoption of business intelligence analytical tools and business performance overall in terms of profit, revenue and shareholders' returns within industrial peers, all of which highlight the value of business intelligence in an organisation.

Olbrich et al. (2012) noted that BI systems can improve efficiency by saving time in developing reports, validating data, reducing the number of different reporting toolsets and maintenance/integration costs, including streamlined security management, etc. Furthermore, he noted that BI can make business more effective through identifying marketing and cross-selling opportunities, fraud detection, and better matching of available supply and demand opportunities. Dawson and Van Belle (2013), in a study of three major financial services companies in South Africa, found that the BI system removed the 'Excel hell' of using hundreds of spreadsheets to provide information to managers, and drove efficiency in their back-office processing by enabling faster responses at the operational level in three key capabilities: (a) strategic predictive analytics, (b) operational key performance indicators, and (c) a drill-down reporting system.

Ashrafi et al. (2014) investigated the impact of BI in healthcare delivery in four USA hospitals in the light of the recent Patient Protection and Affordable Care Act of 2010 (PPACA). The act places greater responsibility on hospitals with regard to the sharing of electronic health records with physicians and pharmacists and greater interoperability with other hospitals. Their study found that the new BI system provided four key capabilities that enabled these hospitals to respond to the new US government information sharing requirements: a) organisational memory capability, b) information integration capability, c) insight creation capability, and d) presentation and communication capabilities. Oszak (2014), in summing up the practical value of BI, indicated it cut across organisational, operational, technical, strategic and tactical perspectives. She noted that *"BI enables organizations to better understand not only internal business processes, but also the competitive environment through the systematic acquisition, collation, analysis, interpretation and exploitation of information"* (p.1103). Business intelligence, she points out, allows for the identification of the opportunities and threats that may occur in the market with customers, suppliers and competitors. Furthermore, successful BI can provide decision-makers with information that enables them to make operational, tactical or strategic decisions and to implement metrics-driven management (Negash, 2004; Olszak & Ziemba, 2007).

2.7 Evaluating Business Intelligence Benefits

However, the benefits of business intelligence are sometimes not easy to evaluate. This is one area in which traditional accounting and evaluation techniques such as return on investment (RIO), net present value (NPV), and cost-benefit analysis (CBA), (Parker & Benson, 1988; Willcocks, 1992) are not very suitable for effective BI evaluation. While some business intelligence benefits such as reducing costs from the consolidation of IT systems, and efficiency savings from the use of a business intelligence system are measurable, many of the BI benefits are intangible, and consequently not easily quantifiable (Irani & Love, 2001; Anderson & Lanen, 2002; Lucas, 1993; Liang & Tang, 1992).

Firstly, a business intelligence system generates information and knowledge, which have to be utilised before the effects are seen. The effects, in themselves, are intangible by their very nature, e.g. improved decision-making processes. The decision made may eventually have financial consequences; however, it is difficult to quantify the contribution of intangible phenomena. The other issue is distinguishing between the specific benefits received due to BI from the impact of other factors that could contribute positively to decision-making, and this in itself can be challenging. Many other factors may affect the success of business, e.g. actions of competitors, changes in customers' behaviour, good management and business environment, such that benefits are often difficult to attribute to a single factor or identify on the balance sheet. Therefore, a key challenge in measuring the effects of BI is distinguishing what part of a phenomenon, say increased market share, results from increased knowledge produced by BI and what is caused by some other factors (Gibson et al., 2006). However, Lönnqvist and Pirttimäki (2006) argued for the need to measure the benefits of BI, firstly, to prove that it is worth the effort to justify the investment to prospective business sponsors, and secondly, to assist in managing the BI process. Historically, academics have made numerous attempts to measure information systems benefits, using various frameworks, models and techniques. Some have used monetary measures as a particular benefit from a system, while others gave subjective quantification using proxy indicators such as customer satisfaction; (Keen, 1981; Strassman, 1990; Hares & Royle, 1994; Counihan et.al., 2002), which in themselves are controversial.

Hannula and Pirttimaki (2006), and Elbashire et al. (2006) created models that measure the benefit of business intelligence. Elbashire et al.'s (2006) model, measures the extent of business intelligence use in business processes in line with levels of organisational performance. They are of the opinion that organisational performance gives an indication of business intelligence use in both processes and at the organisational level. However, such measures are often neither sufficiently close to be taken as tangible measure of benefits, nor sufficiently consistent with the firm's strategic intention regarding the use of the technology to be taken seriously (Lönnqvist & Pirttimäki, 2006). Gibson et al. (2004), in evaluating the intangible benefits of business intelligence, noted that by their strategic nature, business intelligence benefits are dispersed throughout the business, and this is one of the reasons why BI evaluation, perhaps in comparison to traditional techniques such as return on investment (RIO), may be contentious or difficult. Moss and Atre (2004) argued that rather than stress specific measures of BI benefits, which will most likely be varied, reiterating the benefits as an enabler will help to justify business intelligence initiatives and make management feel more comfortable about funding the BI projects and engaging in its' implementation.

2.8. Future of Business Intelligence

Business intelligence systems operate in a fast-paced information technology industry and for an emerging field, today's novel features and implementation could be seen as legacy system in a short time. Bose (2002) noted that businesses cannot predict the future with certainty, but organisations can prepare themselves for it in some way. This raises the question: what are some of the emerging trends and developments in the BI industry that implementers and practitioners may need to be aware of in order to make their implementations more relevant?

Henschen (2014), in an industry survey of 297 respondents regarding the top five trends in business intelligence and big data analytics for 2015, indicated: (a) cloud and mobile BI innovation, (b) big-data exploration, (c) cloud-based data warehousing, (d) increase in adoption of Hadoop and NoSQL for faster, more efficient and flexible data mining techniques, and (e) data quality concerns are easing, with the adoption of newer data mining techniques such as those described above. Similar studies (Chen et al., 2012; Verkooij & Spruit, 2013; Chang, 2014) highlighted big data analytics; mobile BI; self-service BI and the simplification of tools; real-time data analysis; increased statistical simulations and prediction; and growing professionalism in the BI field, as some of the contemporary issues in business intelligence.

Grolinger et al. (2013) defined big data as consisting of unstructured, quasi-structured and semi-structured data such as internet blogs, e-mails, text documents, photos, sounds, data streams, social media content, photographs and even colour. A typical blog has no predefined field or category, while social media formats such as Facebook and Twitter, and other professional networking groups such as LinkedIn are now used for dynamic online interactions between people (Nicholson 2011; Zikopoulos et al., 2014). Others forms of unstructured data are text streams and click stream analysis, such as Google analytics (Turban et al., 2011). Chen et al. (2012), noted that social media analytics present a unique opportunity for businesses to treat the market as a "conversation" between businesses and customers instead of the traditional business-to-customer, one-way "marketing" (Lusch et al., 2010). While the existing business intelligence technologies have made progress in integrating structured data stored in BI systems, the next big challenge is how to incorporate unstructured data, often referred to as "big data", into the BI data mix (Eckerson, 2012).

Chen et al. (2012) stressed that future business intelligence and analytical systems will require mature and scalable techniques for extracting and integrating text mining and other forms of unstructured data, to maximise the business benefit from BI. They noted that cloud computing[4] and mobile business intelligence are becoming increasingly important. With increasing competition, business intelligence users expect to access their data from anywhere and on any type of mobile or handheld devices such as the iPad, iPhone, and other smart phones. These technologies are transforming the ways in which businesses and individuals interact. According to *The Economist* (2011), in Chen et al. (2012), the number of mobile phones and tablets (about 480 million units) sold surpassed the number of laptops and PCs (about 380 million units) for the first time in 2011. The advent of cloud computing means that it is easier to shrink and deploy a lighter version of traditional BI functionalities, such as reports, dashboard or BI graphics designed for standard PC screens, to fit onto mobile devices (Saylor, 2012). Following on from the above is the simplification of tools and self-service business intelligence. Verkooij and Spruit (2013) depicted a framework of mobile BI implementation (MOBII) that would take advantage of emerging web applications optimised for mobile devices. This, they stated, would offer the capability to deliver business intelligence insights like key performance indicators (KPIs), dashboards and scorecards, via web-based device portals and other mobile devices, allowing employees to make fact-based

[4]This is the deployment of IT applications and infrastructure as a service managed remotely via the cloud, as opposed to traditional internally hosted solutions (Michael Saylor, 2012)

decisions anytime and anywhere, and have access to data besides their desktops or laptops. Victor Chang (2014) discussed business Intelligence as a service (BIaaS) in the cloud, and noted that the recent problems in the financial services sector occurred because of inaccurate and inadequate assessment of risk that arose in part from the constraints of operating in desktop environments. He pointed out that a framework of business intelligence as a service (BIaaS) in the cloud would remove the limitation of traditional BI desktop access. This would enable financial services companies to compute risk and pricing models in real time, anywhere, and thus offer better performance, efficiency, lower costs and better integration with other financial services.

Turban et al. (2011) envisaged the delivery of operational business intelligence information with zero latency, possibly within seconds of business events. Real time business intelligence consists of real-time information delivery; real-time data modelling; real-time data analysis; and, real-time action based on insights (Zhan Cui et al., 2005). While traditional business intelligence presents historical information to users for analysis, real-time business intelligence compares current business events with historical patterns to detect problems or opportunities automatically. This automated analysis capability enables corrective actions to be initiated and/or business rules to be adjusted to optimise business processes. Harman (2007) noted that business analytics and forecasting are becoming the main differentiators in business intelligence. The demand for more in-depth predictive analysis and data simulation, a domain that used to be the realm of scientists and special statisticians, is increasing from normal users as business competition increases. Thus, the trend is the increasing quest to bring this exclusive in-depth data analysis to the mainstream of ordinary BI users. This means that BI forecasting tools need to mature and be made easier to use to help ordinary businesses users identify emerging trends and make better plans (Turban et al., 2011).

Another emerging feature in this new BI industry, resulting from increasing reliance on data analysis, is the nature and increasing demand for BI professionals. Chen et al. (2012), in a report by the McKinsey Global Institute, a leading worldwide management consultancy firm predicted that by 2018, the *"United States alone will face a shortage of 140,000 to 190,000 people with deep analytical skills, a shortfall of 1.5 million data-savvy managers with the know-how to analyse big data to make effective decisions"* (Manyika et al., 2011, p.27). What this means is an acute shortage of BI skills that implementers may need to be aware of, but which will also create opportunities in an emerging discipline for professionalism and business intelligence training.

Eckerson (2012) and Chen (2014) discussed other emerging BI technologies arising from cloud computing such as: cloud data warehouses, web mining techniques, opinion mining techniques, mobile mining techniques and semantic processing, and data streaming techniques, which are being applied in building business intelligence systems (Verkooij & Spruit, 2013). These were discussed in section 2.4: Business Intelligence System Architecture. Eckerson (2012) stressed that the next-generation of BI architecture and analysis should employ a mixed data "sand box" that fully integrates relational and non-relational BI mix, using Hadoop and NoSQL. These techniques do not force data normalization rules and constraints of predefined and consistent dimensional data models of existing relational database systems.

Other emerging trends in business intelligence architecture are specialised analytical platforms with a tightly integrated appliance of hardware and software with huge processing and memory power designed explicitly to run ad hoc queries against large volumes of data at blindingly fast speeds. These specialised systems are different from the standard general-purpose data management systems used to implement business intelligence data warehouses. Table 2.3 below summarises some components of this emerging purpose built BI data warehousing system.

Table 2.3: Emerging Components of Purpose Built BI system

Table 1. Types of Analytical Platforms

Technology	Description	Vendor/Product
MPP analytical databases	Row-based databases designed to scale out on a cluster of commodity servers and run complex queries in parallel against large volumes of data.	Teradata Active Data Warehouse, Greenplum (EMC), Microsoft Parallel Data Warehouse, Aster Data (Teradata), Kognitio, Dataupia
Columnar databases	Database management systems that store data in columns, not rows, and support high data compression ratios.	ParAccel, Infobright, Sand Technology, Sybase IQ (SAP), Vertica (Hewlett-Packard), 1010data, Exasol, Calpont
Analytical appliances	Preconfigured hardware-software systems designed for query processing and analytics that require little tuning.	Netezza (IBM), Teradata Appliances, Oracle Exadata, Greenplum Data Computing Appliance (EMC)
Analytical bundles	Predefined hardware and software configurations that are certified to meet specific performance criteria, but the customer must purchase and configure themselves.	IBM SmartAnalytics, Microsoft FastTrack
In-memory databases	Systems that load data into memory to execute complex queries.	SAP HANA, Cognos TM1 (IBM), QlikView, Membase
Distributed file-based systems	Distributed file systems designed for storing, indexing, manipulating and querying large volumes of unstructured and semi-structured data.	Hadoop (Apache, Cloudera, MapR, IBM, HortonWorks), Apache Hive, Apache Pig
Analytical services	Analytical platforms delivered as a hosted or public-cloud-based service.	1010data, Kognitio
Nonrelational	Nonrelational databases optimized for querying unstructured data as well as structured data.	MarkLogic Server, MongoDB, Splunk, Attivio, Endeca, Apache Cassandra, Apache Hbase
CEP/streaming engines	Ingest, filter, calculate, and correlate large volumes of discrete events and apply rules that trigger alerts when conditions are met.	IBM, Tibco, Streambase, Sybase (Aleri), Opalma, Vitria, Informatica

Source: Eckerson 2012

2.9 Information System Project Implementation

The last sections discussed BI system architecture, components, characteristics and emerging trends and development. This section discusses the project life cycle of business intelligence system implementation. Given that business intelligence is a class of information management system, the study started firstly with a review of the process and approach to information system project implementation generally, before discussing the business intelligence project life cycle. Somers and Nelson (2001) noted that it is important to understand the information system (IS) project lifecycle in order to manage and monitor critical areas during its implementation, and to know where in the process to address them effectively. They stressed that this is important to avoid potential failures and to ensure that the promised information system benefits can be realised. In general, IT implementation stages are depicted as consisting of between four and six stages (Cooper & Zmud, 1999; Fiona & Delago, 2006).

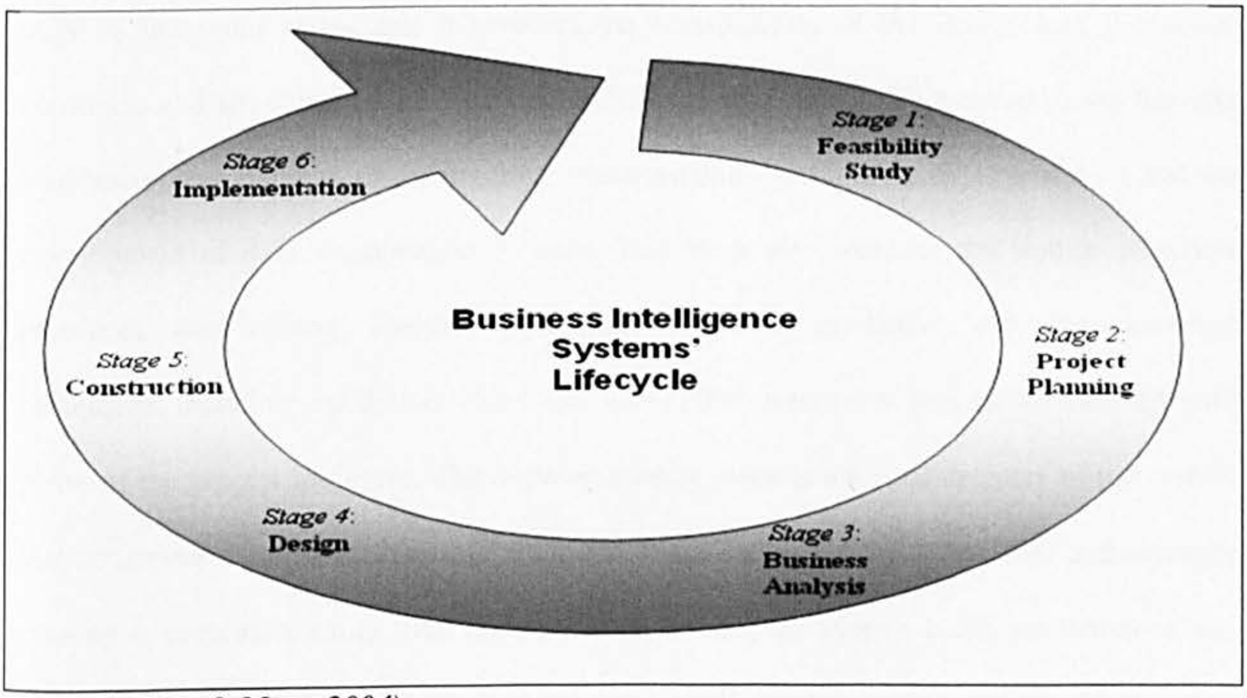
Cooper and Zmud (1999) defined an IT implementation lifecycle as a staged process of interrelated task and activities, coordinated to achieve a desired implementation objective. They developed a model of IT implementation that comprises six lifecycle stages: *initiation*, *adoption*, *adaptation*, *acceptance*, *routinization* and *infusion*, all interrelated in a series of organised events that lead to the completion of an IT project. Fiona and Delago (2006) proposed a model of an enterprise resource planning (ERP) system based on process theory approach, consisting of four stages: c*hartering stage, project stage, shakedown stage and the onward and upward* stage. The chartering phase of their process focuses on creating the business case for the project and identifying resource requirements and solution constraints. This relates directly to the *initiation and adoption* stage of (Cooper & Zmud, 1999). The *project phase* comprises the system design, configuration and integration with other systems, as well as testing and rollout, including user training. The *shakedown phase* is identified as the time between "going live" and "routing use", which is similar to the *acceptance and routinization* stage of Cooper & Zmud (1999). During this phase, outstanding bugs are fixed, the system is tuned for performance, and users are retrained if necessary. The onward and upward phase refers to ongoing maintenance and system enhancements to suit the evolving business needs of the organisation, which relates to the infusion stage of Cooper & Zmud (1999). Nelson (2001) examined the impact of critical success factors (CSFs) across the stages of enterprise resource planning implementation, following Cooper and Zmud's (1999) proposal. Their study found that organisations must not only learn how to identify the CSFs, but they must also know how to manage them across the different stages of the project life cycle, to ensure that the promised benefits can be realised and potential failures avoided. They stressed that the *"best guarantee for success lies in front end preparation that focus on building a solid foundation to support the challenges down the road"* (Nelson 2001, p.8).

2.10 Business Intelligence Implementation Project Lifecycle.

Business intelligence systems share some of the characteristics of the traditional IT project development lifecycle of different phases and stages discussed above (Cooper & Zmud, 1999; Markus & Tanis, 2000; Fiona & Delago, 2006). However, Olszak and Ziemba (2007) cautioned that BI system implementation is a more complex undertaking, requiring appropriate infrastructure and resources over a longer period of time and that it shares some similarities with IT infrastructure projects such as Enterprise Resource Planning systems (ERPs). Jamaludin and Mansor (2011) and Moss and Atre (2004) stressed in particular that business intelligence implementation has its own unique characteristics, which include the coupling of different middleware technologies and the integration of data from different application systems, and is very much unlike conventional application system implementation. These characteristics and distinctions were discussed in section 2.5.

Moss and Atre (2004) developed a six-stage project lifecycle made up of 16 steps for business intelligence project implementation. Their stages comprise: *initiation, planning, business analysis, design, construction and implementation.* Figure 3.1 below shows the business intelligence project lifecycle.

Figure 2.7: Business Intelligence Project Life Cycles



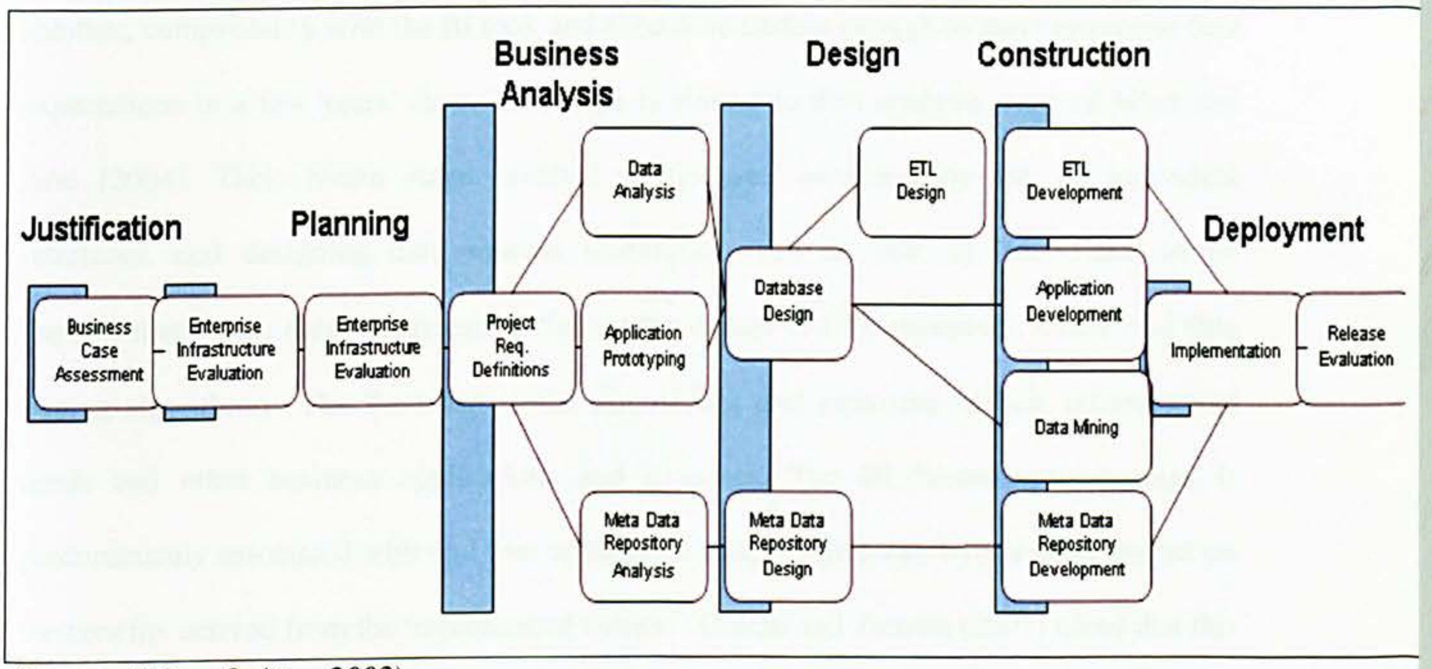
Source: (Atre & Moss, 2004)

The ***feasibility*** stage encompasses the project ***justification*** and business case where the project needs and opportunities are clearly identified, similar to that of Cooper & Zmud (1999). The ***project planning*** stage involves an evaluation of organisational capabilities to sustain and accomplish the BI project, including planning for requirements, resource and organisational needs, as well as planning for change. This stage involves developing a detailed project management plan. The ***business analysis*** stage involves business and data need analysis including functional specifications and prototyping. At this stage, BI tools and software selection might be undertaken based on the data and functional needs analysis. The ***system design*** stage involves the data and application conceptualisation, visualisation and design. During this stage, the logical and physical model design are defined, refined and mapped to the data storage and ETL processes of data extraction, transformation and loading. The stage also involves multidimensional modelling through OLAP[5] and the design of a metadata repository, which essentially is the definition of the data used. The ***construction stage*** is the build stage, and it involves the transposition of the design into the actual constructs and structures of the business intelligence application. This encompasses the data warehouse development, data extraction, transformation and loading ETL processes and the development of data visualisation formats. This stage also includes the testing of access interfaces, data mining, analysis algorithms, and other predictive and data clustering techniques, including validation. Moss and Atre (2004) referred to this as the most difficult phase of the project life cycle. The ***implementation stage*** is the final delivery of the system that comprises data loads, data validation and visualisation. At this stage, user and manager training is organised while final documents describing the system build, performance and parts of the system that will need enhancement, as well as other technical support documents, are prepared. Also at this stage, the final data loading process, application and user setups are accomplished. From the business perspective, preliminary conclusions on the final cost of the project are drawn and at some point in time, a post implementation review, evaluation and system appraisal is undertaken.

[5] OLAP refers to the online analytical processing and relates database schema design (Moss & Atos, 2003) discussed in section 2.6.

Figure 2.6 below illustrates in detail the 16 tasks in the business intelligence implementation project life cycle of Atos and Moss's (2003) model.

Figure 2.8: Detailed Business Intelligence Project Lifecycle

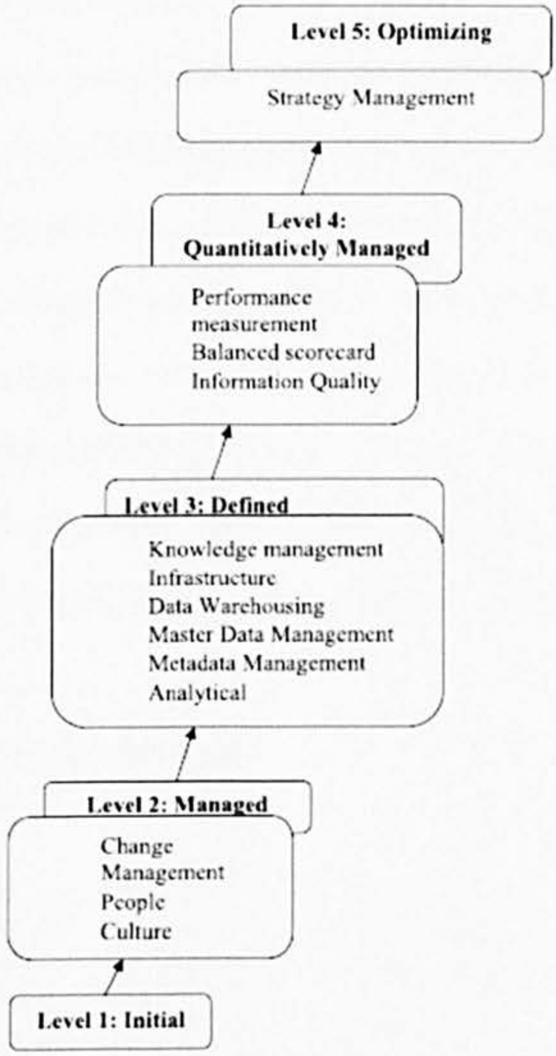


Source: (Moss & Atre, 2003)

Olszak and Ziemba (2007) proposed two major stages of BI implementation, namely, the ***BI creation*** and ***BI consumption*** stages. The BI creation stage is further divided into five sub stages: the definition of the BI undertaking, the identification and preparation of source data, the selection of BI tools, design and implementation, and the discovering and exploring of informational needs. The *definition of the BI undertaking* sub stage of Olszak & Ziemba (2007) is similar to the feasibility stage of Moss and Atre (2004). Accordingly, a general vision of the BI system and how it relates to business objectives are specified, including the specification of informational needs of the organisation with attention to the data needs of key IT decision makers. The *identification and preparation of source data sub-stage* identifies relevant internal and external sources and also verifies the reliability of these sources. While undertaking this task, Olszak and Ziemba (2007) noted that it is worth following the instructions of Błotnicki, & Wawrzynek (2006), such as finding data that are important to the business, finding data that are related but exist in different information systems, and the description of the logical structure of data found. The *selection of BI tools stage,* according to Olszak and Ziemba (2007), should consider functionality, complexity of solution, compatibility with the BI tool, and should be current enough to meet enterprise data expectations in a few years' time. This stage is similar to data analysis stage of Moss and Atre (2004). Their fourth stage involves *design and implementing* the BI individual interfaces, and designing data schema techniques such as 'star' or 'snowflake' to be implemented in the data warehouse, including the design of ETL processes, OLAP and data mining algorithms. The final part is the *discovering and exploring* of new informational needs and other business applications and practices. The BI "consumption" stage is predominantly associated with end user application usage, which can have a great impact on the benefits derived from the implemented system. Olszak and Ziemba (2007) noted that this stage requires users to show their initiative to harness the system, and depending on emerging needs, users should be able to create, author and analyse reports relevant to a business questions and interpret the results obtained. Olszak and Ziemba's (2007) model, although similar to Moss and Atre's (2004) model discussed earlier, it nonetheless places equal emphasis on both the "***BI Creation***" and "***BI Consumption***" stages.

Chuah and Wong (2012) developed an Enterprise Business Intelligence Maturity (EBIM) model to assist organisations in managing their BI implementation. Their model was based on the earlier IT maturity model of Paulk et al. (2006). The Chuah and Wong's (2012) BI maturity model consists of two major parts: the ***staged representation*** and the ***continuous representation***. The *staged representation* is further sub-divided into five levels, namely: *initial, managed, defined, quantitatively managed and optimising* (see figure 2.6).

Figure 2.9: Business Intelligence Maturity Model



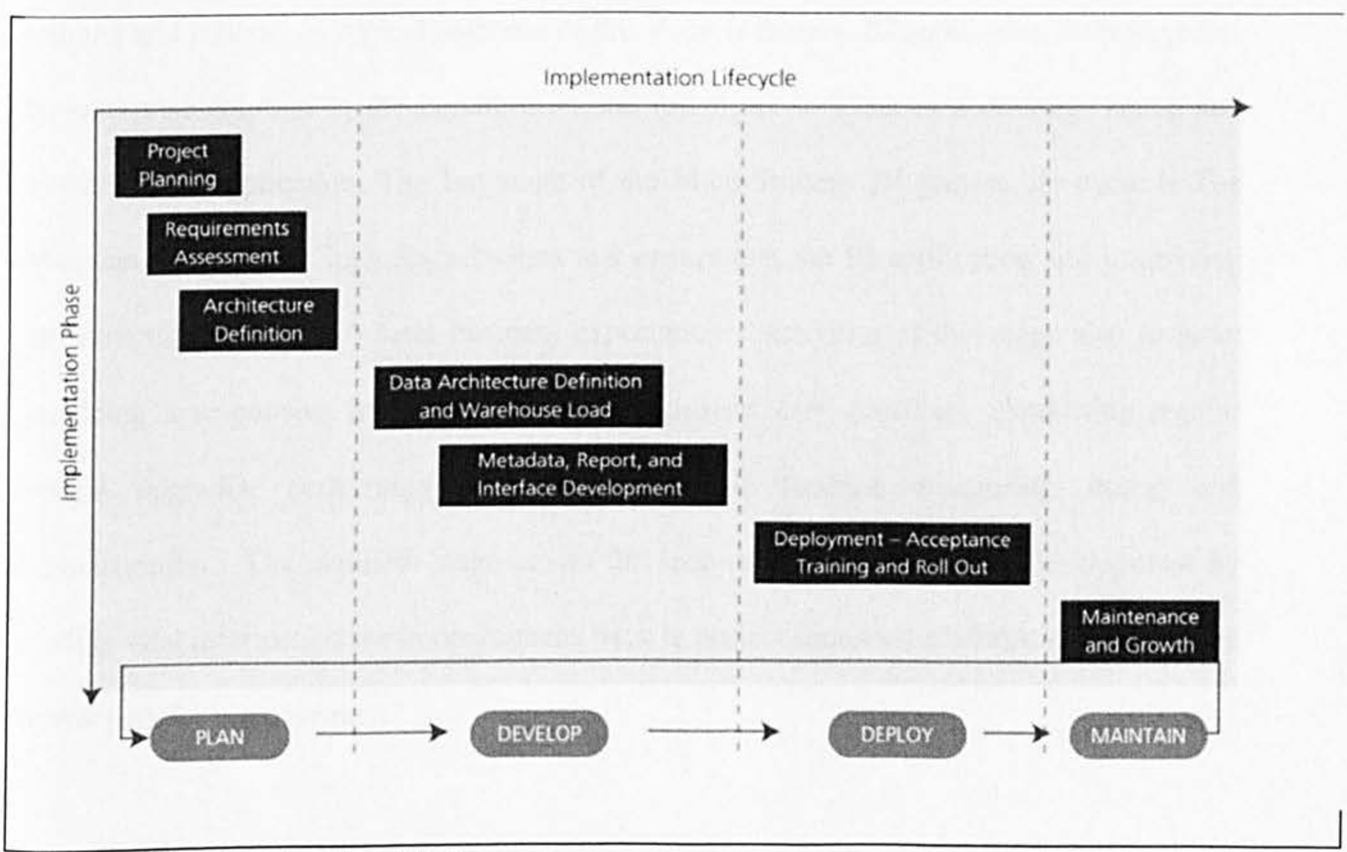
Developed by author

Fig. 2. Proposed staged representation of Enterprise Business Intelligence Maturity model (EBI2M)

Source: (Min-HooiChuah & Kee-Luen Wong, 2012)

At the ***initial level,*** there are no well-defined BI processes and needs are chaotic. At the ***managed level***, efforts are made to concentrate on change management, organisational culture and people, but not much is archived. At the third ***defined level***, enterprise business intelligence needs are defined, and implementation processes are standardised, documented and integrated with other organisational processes. This level, they noted, contains the data warehouse, master data management, and analytical, infrastructure and knowledge management. In the fourth ***quantitatively managed level***, the enterprise business intelligence EBI process and activities are controlled and managed based on quantifiable models and tools. Hence performance management, balanced scorecard and information quality factors are placed at this level. The sixth level, the ***optimising level***, is where organisations establish structures for continuous improvement; this includes the strategic management factor. Chuah and Wong's (2012) business intelligence maturity model is, in many ways, similar to Olszak and Ziemba's (2007) model, which also contains two major stages of BI implementation, namely, the BI creation and BI consumption stages. Bedell (2013), in discussing the MicroStrategy enterprise business intelligence architecture, divided the project life cycle of BI into four major stages: a) planning stage, b) design stage, c) deployment stage, and d) maintenance stage.

Figure 2.10: MicroStrategy BI Project Life Cycle



Source: MicroStrategy Inc. 2013

The planning stage, akin to Atos and Moss's (2004) model, involves the project definition, requirement gathering and architecture definition. An outcome of this stage is the architecture definition, and hardware and software specifications for the development, test, and user acceptance environments, including defining training, needs for production, and the maintenance and support requirements. Another outcome of this stage is the security architecture, backup and recovery strategies, and user Interface Style guides. The Development Stage of MicroStrategy (2013), again akin to Moss and Atre (2003) and others, involves the design, construction and testing. An outcome of this stage involves the development and building of all of the components of the BI application. This involves building the data warehouse, the extract-transform-and-load routines, the schema layer, the application layer, and reports, scorecards, dashboards and all activities around developing the custom user interfaces. The Deploy Stage involves: system deployment, system acceptance, training and rollout. A typical outcome of this stage is that the BI application is deployed as an enterprise solution in the organisation and rolled out to users as a desktop, laptop and mobile client application. The last stage of the MicroStrategy BI project life cycle is The Maintain Stage. This includes activities that ensure that the BI application and underlying infrastructure continue to meet business expectations. Activities at this stage also include: providing a responsive help desk to address business user questions, conducting regular system upgrades, performing periodic system and database monitoring, tuning and administration. The maintain stage closes the loop of the BI application development by feeding vital information for improvements back to project sponsors, planners and application developers for improvement.

It could be noted that the Bedell (2013) four-stage BI project life cycle is very similar to that of Atre and Moss's (2004) and Olszak & Ziemba's (2007) six stage project life cycle models discussed earlier. The reason for all of these expositions on approaches and processes regarding the business intelligence implementation project life cycles (Moss &Atre, 2004; Olszak & Ziemba, 2007; Chuah & Wong, 2012; Bedell, 2013) is to increase the theoretical understanding and appreciate the efforts involved in BI system implementation.

2.11 Chapter Summary

This chapter provided a comprehensive overview of the phenomenon of business intelligence including its evolution, definitions, concepts, the different schools of thought and perspectives. The review found that the construct of BI is multifaceted, but there is a general agreement on the need for BI to gather, process, integrate, analyse, and present business information from a holistic perspective to aid better decision-making. The study thereafter reviewed the value of BI systems including the problems with evaluating the practical benefits, some of which could be intangible. This was followed by a review of the architectural component of the business intelligence system, and what differentiates business intelligence from other conventional information management systems. The chapter then discussed some of the emerging trends in the field of business intelligence that organisations need to be aware of in order to make implementation more relevant, and finally, it discussed the project life cycle of business intelligence implementation. Overall, this chapter explored the fundamental concepts that informed the research and provided the theoretical foundation for the rest of the study.

CHAPTER THREE: LITERATURE REVIEW PART II

BI IMPLEMENTATION AND CONCEPTUAL FRAMEWORK

3.1 Introduction

This chapter, the second part of the literature review, explores the themes, arguments, theories and models of information system success and the critical success factors, grounded in general theories of information management system research, and then focussed on what they mean for business intelligence implementation success. This is followed by a critique and evaluation of the existing literature on the critical success factors of business intelligence and the development of the research conceptual framework.

3.2 Theory of Information System Success

To develop a success model of business intelligence implementation, one must firstly articulate what constitutes that success, and importantly, what are the necessary and sufficient factors or the critical factors for realising that success. Given that business intelligence is a class of information system (IS), the study started by looking at how success is measured for IS in general, and then narrowed the investigation to BI success. Essentially, what is information system success and what are the attributes of information system success, particularly with regard to a business intelligence system?

Prior information systems research viewed IS success from different perspectives and used various definitions and models as measures of IS success. Some of these include the degree of user satisfaction, system quality (DeLone, 1992; DeLone et al., 2003; Santhanam et al., 2000; Hartono et al., 2007), decision support (Kwon et al., 2006), business profitability (Hartono et al., 2007), degree of improved business performance, and perceived net benefit

(Seddon et al., 1999; Grover et al., 1996). Perhaps the most commonly referenced model of information systems success was proposed by DeLone and McLean (1992, 2003), whose study evaluated nearly 200 articles that measured IS success, and then synthesised these measures into a model of information system success (see Figure 3.1). DeLone and McLean (1992) identified six factors in their findings that had mostly been used as measures of IS success. These were: *system quality, information quality, use, user satisfaction, individual impact and organisational impact.* DeLone and McLean's (1992) model suggested that the use of an information system and user satisfaction with regard to that system (system quality) lead to individual and organisational benefits from that system. Further empirical studies, (Fraser & Salter, 1995; Seddon & Kiew, 1994) found that some of these taxonomies are related to one another, with higher levels of data and system quality associated with higher levels of organisational perceived net benefits.

Figure 3.1: Information System Success Model.

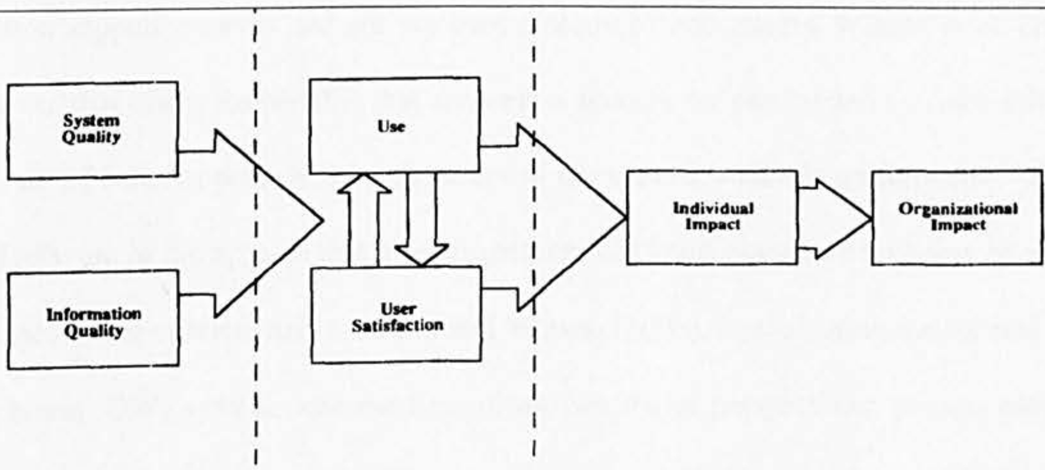


FIGURE 2. I/S Success Model.

Source: (DeLone & McLean, 1992)

Ten years later, DeLone (2003) modified their original model to include service quality. Use and user satisfaction were reclassified as system usage, and individual impact and organisational impact were combined into a single construct called net benefit, as a measure of success. This modification, they noted, was necessary to accommodate the growth of management support systems and the advent and development of e-commerce systems. Since then, DeLone and McLean's (1992) model had become a de facto reference, upon which other information system studies have drawn, (Watson & Wixom, 2001; Hoon & Chan, 2006; Hwang; Hongji & Xu, 2006; Turban et al., 2007; Yeoh & Koronio, 2010).

However, these measures of IS success have not been without controversy, making the task of defining information system success more difficult. For example, system use and or user satisfaction are often found to be more important measures of IS success, (Davis, 1999; Dedrick et al., 2003; DeLone, 1991), while others emphasised the perceived net benefit, (Seddon 1995; Wixom & Watson, 2001). Wixom and Watson (2001), in their study of data warehouse success, found user satisfaction to be insignificant, supposedly because data warehouse systems, unlike most operational systems, are feeds to other reporting and decision support systems and are not used directly by end clients. Wixom et al. (2001) also observed that often, the benefits that are seen as success are determined by some self-reported measure of benefits perceived by the users of the system, which is questionable. Ein-Dor et al. (1998) are of the opinion that a better measure of IS success would probably be a weighted averages of the criteria. Ariyachandra and Watson (2006), in evaluating the success of a data warehouse (DW) system, saw the issue from two major perspectives: process performance and infrastructural performance. The process performance perspective sees DW success in terms of budget and timely considerations, while the infrastructural perspective sees DW success in terms of the system quality and the standard of its output (DeLone & McLean 1992, 2003). However, they cautioned that the two perspectives are not necessarily correlated. For example, an overspent and longer time duration project could perhaps deliver better infrastructure performance than a project that was is conducted in a short time and to budget, but this does not necessarily mean that it was more successful. Hwang and Xu (2007), in a similar study on data warehouse success criteria, highlighted the speed of information retrieval, improved productivity, better decision support and ease of use.

As with the concept of information system success, IS failure has also been explored from different perspectives. Lyytinen and Hirschheim (1987) proposed a framework that defined IS failure in four major theoretical categories. First is *correspondence failure,* which they defined as the failure of the IS system to meet the original expectations. Second is *process failure,* which they defined as a failure of the development process to either produce an IS system that works satisfactorily, or one that does not overrun in terms of cost and time. Third is *interaction failure*, which they defined as failure of the system arising either because it is hardly ever used or because there are major problems with its usage. This is not so much a mismatch between expectations and delivery, but has more to do with how the delivered system is utilised with regard to usage initial expectations. The final category is *expectation failure,* which Lyytinen and Hirschheim (1987) described as a combination of the above three failures and importantly, the failure of the IS system to meet the original expectations of the stakeholders. Lyytinen and Hirschheim (1987) listed elements such as goals, technology, economy, control, perception of the development process, and organisational nature as having major impacts on the development *expectation failures.* Furthermore, they noted that constructs such as data problems and the complexity of system are responsible for *use expectation failures.* As expected, there have been criticisms of this model of information system failure and it has been seen to be pluralistic. Sauer (1993), in offering a stricter definition of IS failure, noted that an IS system should only be regarded as having failed when either the development or the operation of that IS system ceases, leaving the stakeholders in a state of dissatisfaction. Sauer (1993) defined information system IS failure more from the perspective of project termination, rather than in terms of expectation failure, as in Lyytinen (1987).

Researchers have also found that information system success can be context specific, In other words, the type of information system defines the appropriate measures to be used (De Leone, 2003; Caldeira et al., 2003). Context, as used by these authors, can refer to the level of analysis, for example an individual, group, firm, organisation or industry (Ein-Dor et al., 1982; Seddon et al., 1999), the type of information system studied (DSS, ERP, CRM, Transactional, Web, inter-organisational etc.) (Seddon et al., 1999), the size of the organisation (Caldeira et al., 2003; DeLone, 2003), or even the country in which the study took place (Caldeira et al., 2003). The implication of all of the above analyses, suggests that measures for success or failure, for example in business intelligence research, need to be based on BI specific characteristics.

3.3 Operationalising Business Intelligence System Success

Therefore, the question is, which variables are appropriate for BI success given the complex and varying definitions of IS success? Deleone and Maclene (2003, p.13) recommended that "*the selection of IS success dimensions and measures should be contingent on the objectives and context of the empirical investigation, but, where possible, tested and proven measures should be used*".

In this study, business intelligence success is defined as the capability of the system to enhance the potential business benefit, which the BI system was intended to provide. However, how an organisation defines BI success depends on what benefits it needs from its BI initiative (Miller, 2007). For operational purposes therefore, the study has adopted the following five measures of business intelligence success: system quality, data quality, user satisfaction and usage quality, decision support quality and perceived net benefit. These measures are based on the works of DeLone& McLean (1992, 2003) on IS success, for whom there are more than 2000 citations in the field of information system research, making this highly appropriate, given that business intelligence is a class of information system.

3.3.1 System Quality

The is the technical quality of a BI system with respect to information processing quality, available tools, system user friendliness, system performance, flexibility, scalability, adaptability, availability, reliability, time responsiveness, usability, and ability to integrate with existing systems (DeLone, 1992; Wixom & Waxon, 2001; Melville et al., 2004; Kwon et al., 2006; Clark, 2007; Ramamurthy et al., 2007; Wang et al., 2008, Yeoh & Koronios, 2010). Integration for example, can be at the database layer, application layer or business process layer, and at the user layer; yet these three layers are not isolated from each other (White, 2005).

3.3.2 Information Quality

Data and information quality refers to the accuracy, completeness, comparability, and reliability of the data and information. It also refers to ease of understanding, relevance, data security and data integrity (Clark, 2007; Ramamurthy et al., 2007; Wang et al., 2008). Research has found that proper use of data improves the end-user efficiency and effectiveness, and better informed employees make better decisions leading to organisational efficiency (Watson & Haley, 1997; Fuller & Ariyachandra, 2004). Frishmmar (2003) noted that improved information quality should reduce or remove uncertainty in decision making.

3.3.3 Decision Support Quality

Negash (2004) noted BI assists in converting complex information into effective decisions. He suggested that information requirements differ for different types of decision-making processes from strategic, to managerial and operational, which are aligned with roles and responsibility, which should be well communicated to the different decision levels. Yeoh (2010) stressed that business intelligence systems should improve decision-making quality across operations by presenting relevant and reliable information in a quick and understandable manner. Choo (2002, p.26) noted that it is valuable not only to know what information is needed, but also to know what is not required. He stressed that "*it is a waste of time and resources to gather and analyze information that decision-makers want but a company does not need for success*".

3.3.4 Usage Quality

Usage quality refers to how often the system is used, the nature of use, how it is used, usage pattern and how satisfied users are with the system. Logically, if the system cannot provide any benefit to users, it ceases to be used, and therefore cannot be seen as successful. Johnson (2004) noted that an IS system must satisfy the user for them to continuously use it, and an unused system means millions of dollars of unused software and unrealised returns on investment. Yeoh and Koronios (2010), in their study on BI systems, found that respondents were strongly of the opinion that the system must be seen to continuously support business decision-making processes. An indicator could be the number of people using the system gradually increasing after the initial deployment. However, whether such use is voluntary or whether it is related to people doing their job is another matter (Sabherwal et al., 2006).

3.3.5 Perceived Net Benefit

Seddon (1995, p.354) defined perceived net benefit as "*the sum of all future benefits less all future costs expected to flow from use of an information technology application*". A well-implemented BI system is expected to enhance payoffs by lowering costs, increasing revenues and profitability, improving competitive advantage, improving business processes, supporting initiatives such as customer relationship management and knowledge management, and finally saving time (Wixom et al., 2001; DeLone, 2003; Melville et al., 2004; Sabherwal et al., 2006; Kwon et al., 2006; Wang et al., 2008, Hartono et al., 2007).

Although there are issues with the tangible and intangible benefits of business intelligence and how to measure its contribution to the business bottom line (Lönnqvist & Pirttimäki, 2006; Gibson et al., 2006), as discussed in section 2.6, there is however a general consensus that BI facilitates better decision-making processes and acts an enabler to realising the visible benefits. Table 2.3 below summarises the business intelligence success variables.

Table 3.1 Summary of BI Success Variables:

BI Success Quality	Definition and Measure	References
System Quality	System flexibility, scalable, adaptability, availability, reliability, time responsiveness, Easy to use, speed of information retrieval, integrate with other systems, advanced visualization, advanced predictive analysis, support for mobile BI	Deleone (1992), Wixom & Watson (2001), Wixom & Todd (2005), Melvile et al. (2004), Kwon et al. (2006), Clart (2007), Ramamurthy et al. (2007), Wang et al. (2008), Yeoh & Koronios (2010), Sangar & Iahad (2013)
Information Quality	Information completeness, consistency, integrity, comprehensiveness, clarity, data usability, relevance, uniqueness, comparability, precision, freedom from bias. Better quality information; real time data,	Wixom & Watson (2001), Wixom & Todd (2005), Yeoh et al. (2006), DeLone & McLean (1992), Clark et al. (2007), Seddon (1997), David Arnott (2008).
Usage Quality	User satisfaction, user efficiency, effectiveness, nature of use, patterns, increased number of use, and number of site visits. Easy to use; integration with other systems.	Delone 2003; Raymond 1990; Sabherwal et al 2006; Isik 2009; Yeoh & Kikokis 2010; Hostmann et al. 2007; Sangar & Iahad (2013).
Decision Support Quality	Improved decision support, reduced decision time decision efficiency, effectiveness. Reduce or remove decision uncertainty. Ability to communicate information to different decision levels with associated roles.	Poon & Wanger (2001), Wixom & Watson (2001), Negash (2004), Yeok & Kikokis (2010), Guimaraes et al. (1992) Isik (2009).
Perceived Net Benefit	Cost savings, expanded market, increased revenue, reduced cost, improved productivity, increase profitability, efficiency, competitive advantage, identify new business opportunity.	Seddon (1993), Wixom & Watson (2001), Delone (2003), Gable et al. (2003), Melvile et al. (2004), Sabherwall et al. (2006), Kwon et al. (2006), Wang et al. (2008), Hartono et al. (2007), Yeok & Kikokis (2010), Guimaraes et al. (1992).

Source: Own.

3.4 Theory of Critical Success Factors (CSF)

The previous section introduced the concept of IS success and the attributes of information system success. The next section focuses on what is frequently called "critical success factors", supposedly, the conditions that need to be met to ensure the success of an information system. But firstly, what are critical success factors?

3.4.1 Concept of CSF

One of the earliest proponents of the concept of critical success factors (Boynton & Zmud 1984, p.17) defined it as: *"those few things that must go well to ensure success and which organisation management must give special and continued attention to bring about high performance"*. Pinto and Slevin (1987, p.51) defined it as those *"factors which, if addressed, significantly improve project implementation chances"*. Saraph et al. (1989) defined CSF as those critical areas of managerial planning and action that must be practised in order to achieve effectiveness, which is unique to an industry. Williams and Ramaprasad (1996) describe CSFs as the necessary and sufficient conditions for project success. Hartono et al. (2006, p.257) used the following words to describe their interpretation of CSF: *"success antecedents are those key factors that organisations can manage so that the management of information system is favourably received and the implementation is deemed as successful"*.

The concept of Critical Success Factors (CSFs) is actually traceable to Rockart (1979), who sought to outline a mechanism for identifying the information needs of executives, in which interviews between an analyst and a CEO result first in a set of CSFs and then, into performance measures that represent those CSFs. Rockart stressed two points in this respect, namely: that CSFs should provide a focal point for directing computer based information system (CBIS) development, and, secondly, that the CSF method should result in key information that is useful to a CEO and which pinpoints key areas that require manager's attention. Rockart went on to define CSFs as: *"Limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation".* He further stressed that, *"they are the few key areas where "things must go right" ... and "are areas of activity that should receive constant and careful attention from management* (p.85).

Since Rockart (1979), the concept of critical success factors has been used and applied in different environments. Amberget et al, (2005), for example, undertook a review of various dimensions of CSFs and identified five major critical success factor usage categories:

(1) Hierarchy vs. Group CSF, which relates to industry-specific CSFs (Van Bullen, 1986).

(2) Temporary vs. Ongoing CSFs (Ferguson & Khandewal, 1999).

(3) Internal vs. External CSFs (Arce & Flynn, 1997). Here *"an internal CSF has related actions taken within the organization, while an external CSF has related actions performed outside the organization"* (p. 312).

(4) Building vs. Monitoring CSFs (Van Bullen, 986), which distinguishes between building CSFs, used to achieve certain goals, and monitoring CSFs, used to monitor key issues over a longer time frame.

(5) Strategic vs. Tactical CSFs (Esteves, 2004). Tactical factors are used to achieve short-term goals, while strategic factors are based on long-term opportunities, and contain a great amount of risk. They therefore require long-term planning and are primarily executed by senior executives. According to Ward (1990), normally both are combined for most endeavours.

Amberget et al. (2005) also explored the relationship between critical success factors and organisational objectives, and noted that CSFs are often confused with organisational goals. They defined goals as organisational targets that are established to achieve the organisation's mission. They are specific in terms of what needs to be achieved, when, and by whom. Critical success factors, on the other hand, are the antecedents to realising the goal. Effective goals have a quantitative element that is measurable to determine whether the goal has been achieved. Goals can be decomposed into operational activities to be performed throughout the organisation. Paul Meyer (2004) noted that goals should be S.M.A.R.T: *specific, measurable, achievable, realistic, and timely,* in order to be effective. He noted that where goals do not have this level of specificity, they could be confused with critical success factors.

It is clear from the above exposition that although goals and critical success factors (CSFs) are separate constructs, there is a strong cardinal relationship between them, and identifying the relevant CSF is crucial to achieving a specific goal (Amberget et al., 2005). This raises the question of what set of critical success factors is relevant to BI system implementation. For the purposes of this research, the construct is initially reviewed from within the general information system management (IS) literature, with the aim of identifying which individual construct can impact on the success of a BI project initiative.

3.4.2 Critical Success Factor Studies on Information Systems

Early information system research (Vatanasombut & Gray, 1999) identified 51 critical success factors that were classified into 12 categories. Watson and Haley (1997) identified eight critical success factors, whereas Sammon & Finnegan (2000) discussed their "ten commandments of data warehousing". Seddon (1997), who grounded his research on

DeLone and McLean's (1992) IS success model, identified a positive linear relationship between time spent using a system and the benefits it provides. However, Wixom & Watson (2001) did not find any such significance. Holland et al. (1999) focused on strategic factors spanning the whole project and tactical factors that can be applied to particular parts of the project. Some studies examined problems arising from a lack of fit between the organisation's business objective and the information system (Clark et al., 2007; Hostmann et al., 2007), while others identified perceived user friendliness of the system (Santhanam et al., 2000; Hartono et al., 2007), and level of user experience (Hartono et al., 2007) including user training (Santhanam et al., 2000). Umble et al. (2006) emphasised selection of the software in their discussion of critical success factors. Lapointe and Rivard (2006) noted that how implementers handle the attitude of the project's stakeholders and end-users, affects the success of the project. Other studies have also identified the degree of the developers' skills (Bajwa et al., 1998; Santhanam et al., 2000; Wixom &Watson, 2001) and task characteristics such as degree of problem difficulty and level of system fit, (Hartono et al., 2007).

Reel (2001) summarised what he believed are the essential CSFs in software projects that hold true regardless of the design, development methodology, the implementation language, or the application domain. Some of these, he noted, are strong committed leadership, open and honest communication, and top management support, balanced with a competent and empowered team (Sarker & Lee, 2003; Baker & Baker, 1999; Sammon & Finnegan, 2000; Wixom, & Watson, 2010; Hartono et al., 2007). Proper planning and execution of the implementation schedule is deemed to be crucial, particularly to avoid project "scope creep", which has been identified as a common cause of project failure (Baker & Baker, 1999; Watson, & Ariyachandra 2004; Conner, 2003). Also, the economic issue of adequate funding and the degree of perceived value have been identified as critical success factors from an economic perspective of the project, while other studies have identified user involvement and participation (Watson & Haley, 1997; Wixom & Watson, 2001; Conner, 2003).

Different approaches have also been adopted in the literature with respect to how to explicitly manage identifiable critical sources factors. Somers and Nelson (2001), in a survey of US executives on the critical success factors of an ERP system, found top management support, followed by project team competence, to be the most critical factors in a 'ten commandment list'. However, Sherry Finney (2007), in criticising the CSF approach, observed that it relied too much on the opinions of top management and could be biased. Shaw (2003) ranked critical success factors and placed the technical factors at the lower level of the hierarchy and the organisational factors at the top. He suggested that to achieve implementation success, organisations must successfully manage and pay attention to the lower level technical factors in the hierarchy before tackling the higher level organisational factors. Nah and Delago (2006) examined seven critical success factors for ERP system implementation and upgrade across four stages of the implementation cycle, which they classified as the chattering stage, the shakedown stage, the onward stage, and the upward stage. The authors found that out of the seven categories of critical factors examined, team skills and composition, and communication, were found to be the most important overall factors.

Hartono et al. (2008) summarised the CSFs identified in empirical studies in some key information management systems such as: decision support systems, expert systems, data warehouses, group decision support systems, organisational decision support systems, executive information and management information systems. They ranked the success factors for each of the individual information systems studied. Their study indicated that there is no single key success antecedent factors uniform across all systems for achieving implementation success. Instead, Hartono et al. (2008) noted that organisations must think through carefully what benefits they need most from the system and then manage the corresponding success antecedent accordingly.

3.5 Existing Studies on CSF of Business Intelligence

There exists a lot of work on critical success factor studies in information management systems (IMS) research generally (Sammon & Finnegan, 2000); for enterprise relationship planning systems (Somers & Nelson, 2001; Shaw, 2003; Sherry Finney, 2007); for decision support systems (Hartono et al., 2008); and for data warehouses systems, which are a core component of BI systems (Wixom & Watson, 2001; Hwang & Xu, 2007). However, few empirical studies have been conducted to assess the critical success factors that influence business intelligence system implementation (Armott, 2008; Yeoh & Koronios, 2010; Olszak & Ziemba, 2012; Olbrich et al., 2012; Dawson & Van Belle, 2013; Sangar & Iahad, 2013; Naderinejad et al., 2014). This is perhaps due to its relative newness as a discipline compared to traditional disciplines and the fact that business intelligence research had been led by the industry rather than by academia.

Arnott (2008) derived ten critical success factors from the literature related to decision support systems (DSSs), executive support systems (ESSs) and Data Warehouse systems (DWs), to examine how they were applied in a three-stage lifecycle of a BI project implementation, that took 18 months to complete. He found that the ten identified CSFs were either not applied or only partially applied at the first and second stages of the project, which led to dissatisfaction and cancellation of the BI implementation project. The project was then outsourced to another specialist implementation organisation after 15 months. Their study found correlations between an improvement in project delivery at the third outsourced stage, and the full application of the identified critical success factors at that stage. Anott's (2008) study sought to address previous criticism of the CSF approach, within the context of the dynamics of their application over the life of the BI project.

Yeoh and Koronios (2010), one of most referenced studies on the CSFs of business intelligence, derived a set of critical factors from the literature and conducted a three-round Delphi case study. The respondents comprised fifteen BI systems experts who were then asked which critical success factors would mostly influence BI implementation. Their analyses proposed three major critical success factor categories: organisational related factors (clear vision, business case, and management support and project champion); process related factors (team composition, project management, methodology and change management); and technical related factors (data related factors and infrastructure related factors). These were then corroborated in three case studies with organisations that had implemented business intelligence systems to validate the absence or presence of the identified critical success factors in their implementation processes. The authors' final findings indicated that non-technical factors such as organisational and process-related factors are more influential and important than technological and data-related factors. However, there is concern that the Yeoh and Koronios (2010) study did not propose specific BI success measurement criteria, and therefore it could be subjective. Hawking and Sellitto (2010) used content analysis of industry conference presentations to identify the CSF of enterprise relationship management systems (ERP) that could be associated with BI implementation. They identified 22 critical success factors that could be associated with different variations of BI vendors' software offerings. Where the distinction lies is controversial, as most critical success factors cannot be associated exclusively with a business intelligence software vendor's offering.

Olszak & Ziemba (2012) examined the presence or absence of the three categories of CSF identified in Yeoh and Koronios's (2010) model, namely: organisational, process and technology related critical factors on a small and medium scale (SME) BI implementation in Poland. They noted that while some of these factors were generally present or undertaken in most SME implementations, there were variations in the presence and application of some of the critical factors among the Polish regions.

Elad Harrison (2012) examined the extent to which user attributes and various organisational factors influenced the success or failure of BI implementation projects in a gas engineering company in the Netherlands. The author noted that when users lacked essential knowledge about the BI system, especially regarding how to apply its tools within the business processes, they perceived it as "complex" and tried to "work around" it, which reduced the value of the BI system. They found that "*successful implementation of a BI system largely depends on the roles that the IT department of the firm plays as a promoter, an integrator and as a hub of knowledge and support for users*" (Elad Harrison, 2012, p.11).

Olbrich et al. (2012), and Dawson and Van Belle (2013), employed a three-round Delphi study following a similar research approach to that adopted by Yeoh and Korioinous (2010), to analyse and rank the criticality of the success factors of business intelligence along different dimensions. Olbrich et al. (2012) initially employed 30 CSFs to rank their relevance, variability and controllability and after three rounds of a Delphi interview study, they dropped five of the CSF variables. Their study found that the remaining 25 CSFs rated differently in these three dimensions and constituted six CSF groupings within ranges of high, moderate and low. An important aspect of their study is that contrary to existing ranking-type Delphi studies that are typically limited to a single dimension, this study used a three-dimensional clustering and provided a more distinct view, analysing the conceptual relevance of the CSFs. Overall, top management support, data sources, corporate BI strategy, IT budget and user involvement were found to be most dominant critical success factors.

Dawson and Van Belle (2013) employed 23 CSF in a three-round Delphi study to examine the relative importance of the CSFs used in the implementation of BI in the financial services sector of South Africa, and how they aligned with similar CSFs used in European studies. Their study found that the CSF ranking outcome in their study only correlated partially with those of the European studies examined. However, they noted that five of the factors postulated in their theoretical framework ranked among the seven highest CSFs in the European studies, which provides very strong validation of the framework. At the top of the authors' list were 'committed management support and champion', 'business vision', 'user involvement' and 'data quality' However, they suggested further research to see whether one might discover similar differences and partial similarities in other industries and other emerging economies.

Sangar and Iahad (2013), employing interview techniques, examined the relevance of 20 critical success factors, broadly categorised into two groups, "managerial" and "technological" CSFs, across 3 major stages of a BI project implementation life cycle: a) pre-implementation, b) implementation, and c) post implementation. Their study adopted a project life cycle management perspective, and each stage is further divided into two sub-stages. A similar approach was adopted by Nelson (2001), to examine the relevance of CSF across different stages of Enterprise Resource Planning (ERP) system implementation. Sangar and Iahad (2013) found that the CSFs had a different level of relevance across the different stages of BI project implementation and proposed a model of BI project life cycle implementation. At the pre-implementation stage, the organisation should seriously consider: clear vision and mission, organisational culture and committed management support, organisational readiness, suitable software and hardware, available skills, suitability of hardware and software, and a qualified BIS vendor and service consultant. At the implementation stage, the organisation should seriously consider: change management, top management support, data accuracy and integrity, and a suitable and flexible technical infrastructure. At the post-implementation stage, the organisation should seriously consider: user training and education, and encourage the perceived usefulness of a BIS.

Naderinejad et al. (2014) employed survey data using LISREL to analyse and rank 18 CSF variables in three dimensions: organisational, process and technological, following Yeoh and Koronis' (2010) CSF categorisation. Their study focussed on hospital BI implementation in Hasheminejad, Iran and found that the different CSFs were ranked differently across the three categories. Overall, their study found that the top four CSFs for hospital BI implementation were organisationally related: a) goals and strategy b) financial resources, c) human resources and organizational culture. However they also noted all the major categories organizational, process, and technological factors were equally important.

3.6 Evaluation and Critique of Studies on CSFs of Business Intelligence

While the conclusions and contributions that arose from the studies discussed above are valuable (Yeoh & Koronios, 2010; Hawkings & Sellitto, 2010; Jamaludin & Mansor, 2011; Olszak & Ziemba, 2012; Harison, 2012; Olbrich et al., 2012; Dawson & Van Belle, 2013; Sangar & Iahad 2013; Naderinejad et al., 2014), common characteristics of all these studies however are: (a) existing studies were qualitative and inductive, (b) different studies used different CSFs, (c) they lack clearly defined BI success measures, (d) relationship between the CSFs have not been well explored, and (e) the extent to which the CSFs explicitly explain BI implementation success have not been examined.

Firstly, the existing studies seem to be more concerned with identifying and classifying the critical success factors, and how they are operationalised in inductive qualitative case studies, with most of them using the Delphi interview method (Yeoh & Koronios, 2010; Olbrich et al., 2012; Dawson & Van Belle, 2013). Only Naderinejad et al. (2014) adopted a purely quantitative survey method. While a qualitative approach provides an in-depth analysis and understanding of events as they occur, there is however a concern regarding external validity and generalisability beyond one or a few cases (Yin 1997; Adamala & Cidrin, 2011). Perhaps research would benefit by examining the phenomenon from a different methodological perspective, in order to shed new light on this evolving discipline.

Secondly, the existing studies used different sets of critical success factor variables, often depending on the research interest and background, and research findings seem fragmented, isolated and subjective, making it difficult to compare findings or have a common set of CSF variables upon which the industry can rely (Hwang & Xu, 2008). As noted by Bussen and Myres (1997), a variable taken solely from one perspective can only explain a small proportion of how well the factor contributes to the overall system success. Thus there is perhaps a need to identify, synthesise and harmonise the most re-occurring CSFs used in various studies into a common set of critical factors for practical purposes and professional best practice. This could also help to resolve some of the CSF research conundrums.

Thirdly existing studies have not clearly defined the qualities and measures of the business intelligence success to be realised in their framework, making the perceived outcome of the

BI implementation initiative subjective. Of course the concept of information system success and indeed business intelligence success is itself subjective, as discussed in Section 2.11. However, this gives greater reason for the expected BI success to be well-defined in BI implementation process.

Fourthly and importantly, the relationships between the critical success factors have not been well-explored in existing BI studies; nor has the extent to which some of the identified critical success factors account for the overall implementation success, either collectively or individually. Stephen (2006) noted that the vast majority of critical factor studies have a ''static'' view of the CSFs, often at the development stage of the lifecycle, and generally not explicitly linked to outcomes, arguing that, the relationship between the critical success factors and how they explicitly link to and influence each other affects the final outcome. Hostmann et al. (2007), echoing similar sentiments, pointed out that many organisations do not fully understand the link between the critical factors and the success measures for which the IS systems was developed, stressing that this is one of the major reasons for IS failures. In a similar vein, Hwang and Xu (2008) emphasised that the relationship between the critical factors and success measures should be given greater attention in future studies, noting that most CSF studies investigate either the critical factors or success measures and not both. They suggested that researchers should start including both sets of variables in their models, and test the effect of the critical success variables on the IS implementation success. This point is of particular importance to this study as it highlights an important gap in the business intelligence research that this study seeks to address.

Thus, the aims of this study are: (a) to explore the relationship between the critical success factors; (b) to establish the extent to which the critical factors explicitly impact business intelligence implementation outcomes, and (c) to examine which critical success factors relate to which success measure and most likely to have a greater influence on the realisation of the BI success objective. The next section is a derivation of the critical success factor variables to be used in the research investigation.

3.7 Deriving the Critical Success Factors Research Variables

Following the review above, this study then proposed a comprehensive list of 16 CSF variables for the development of the research conceptual framework. These CSFs were derived from a process of identification, filtering and scoring of about 33 of the most re-occurring critical success factor themes used in 25 academic studies on business intelligence, including similar information systems literature (ERP, BI, DW ESS and DSS). A similar approach has been adopted in the information systems (IS) literature (Anott, 2008; Finney & Corbett, 2007; Hartono et al., 2007; Harison, 2012). Tables 3.3 and 3.4 below illustrate the CSF filtering process. While some factors were eliminated on low scoring, certain factors were grouped under one comprehensive heading as different authors have used different labels for similar factors. For example, the critical factors “Amount of Data" and "Modelling of Metadata", were merged into "Data Management & Integration". Others factors such as "Use of Steering Committee" and “Practical Implementation Schedule" were merged into "Project Management". The study also added a new and untested CSF variable, “*user intuition*”, to the research conceptual framework, which will be validated for empirical relevance and importance, based on the researcher’s theoretical understanding and practical experience as an IT professional. As noted by John Naisbitt (1982), a former chief executive of IBM and later Kodak, ‘*intuition becomes increasingly valuable in the new information society precisely because there is so much data*’ (p.178).

In this study, critical success factors (CSFs) are defined as those practices that an organisation needs to be able to manage in order to ensure successful BI implementation. These factors and practices, if they do not already exist, would need to be developed, and if they already exist, would need to be nurtured. Implicit in this definition is that CSFs are internal factors that are controllable by the organisation, such that external factors and environmental influences not under the direct control of the organisation when implementing the BI system are not taken into consideration. Table 2.4 below summarises the proposed CSF derivation process.

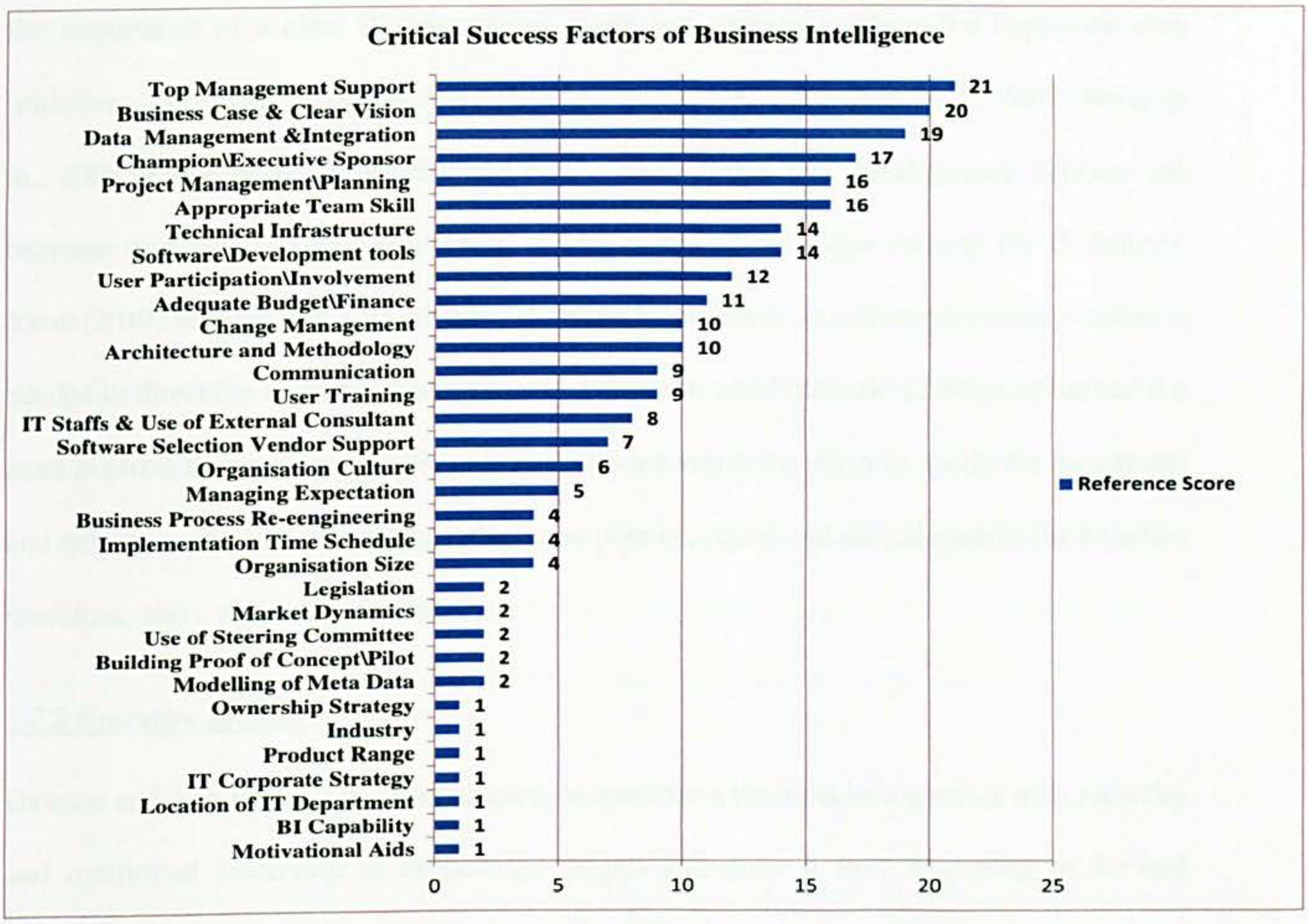
Table 3.2: BI CSF Literature Review Reference Scoring

Authors	IS Discipline	Business Case & Clear Vision	Top Management Support	Champion\Executive Sponsor	Adequate Budget & Finance	Appropriate Team Skills	Software\Development tools	Project Management\Planning	Change Management	Managing Expectation	Data Management	Architecture and Methodology	Technical Infrastructure	User Participation\Involvement	User Training	Organisation Culture	Organisation Size	IT Staffs & Use of External Consultant	Modelling & Use of Meta Data	Building Proof of Concept\Pilot	Practical Implementation Schedule	Communication	Software Selection Vendor Support	Use of Steering Committee	Business Process Re-engineering	Motivational Aids	Market Dynamics	BI Capability	Location of IT Department	IT Corporate Strategy	Product Range	Legislation	Industry	Ownership Strategy
Wixon & Watson (2001)	DW		X	X	X	X	X						X	X																				
Somers & Nelson (2001)	ERP	X	X	X	X	X	X	X	X		X		X		X			X				X	X	X	X									
Poon & Wanger (2001)	DSS			X		X					X	X	X																					
Young-Sook Lee Et al. (2001)	ISS	X	X	X	X	X	X	X			X			X				X																
Little & Gibson (2003)	DW	X	X		X		X	X			X					X		X	X	X														
Fuller & Ariyachandra (2004)	DW		X								X				X									X										
Eckerson (2005)	DW	X	X				X	X			X	X																						
Sammon & Adam (2005)	DW	X		X		X		X		X	X		X									X	X											
Imhof (2004)	DW	X								X		X	X									X												
Hwanga et al. (2004)	DW		X	X	X	X		X						X			X	X																
Nah & Delago (2006)	ERP	X	X	X		X	X		X													X												
King, & Burgess (2006)	ERP	X	X	X		X		X	X	X												X	X											
Chenweth et al (2006)	DW	X	X	X		X	X		X		X	X																						
Wise (2007)	DW	X						X	X		X				X							X												
Yeoh et al. (2006)	BI	X	X	X	X	X	X				X	X		X	X				X	X														
Hwang & Xu (2007)	DW	X	X				X				X			X				X			X													
Arnott & Pervan (2008)	DW\BI	X	X	X	X	X	X	X			X		X																					
Hawking & Sellitto (2010)	BI		X	X	X	X	X	X	X	X	X	X	X	X	X			X					X											
Yeoh & Koronios (2010)	BI	X	X	X		X	X	X	X		X	X	X	X																				
Olszak & Ziemba (2012)	BI	X	X		X	X	X	X	X	X	X		X	X								X												
Elad Harison (2012)	BI	X	X	X				X					X		X	X	X						X			X								
Olbrich et al (2012)	BI	X	X		X			X			X		X	X	X	X	X	X			X	X			X		X	X	X	X	X	X	X	X
Dawson &Van Belle (2013)	BI	X	X	X							X	X	X	X		X	X	X			X				X		X				X	X		
Sangar & Iahad (2013)	BI	X	X	X		X		X	X		X	X	X	X	X	X					X	X	X											
Naderinejad et al., (2014)	BI	X	X	X	X	X	X	X	X		X	X	X		X	X							X		X									
CSF Total Score	ALL	20	21	17	11	16	14	16	10	5	19	10	14	12	9	6	4	8	2	2	4	9	7	2	4	1	2	1	1	1	2	2	1	1

BI : Business Intelligene
DSS: Decisison Support System
DW: Datawarehouse
ERP: Enterprise Relationship Management
IS: Information System

Source: Own.

Table 3.3: BI CSF Literature Reference Scores



Source: Own

The next section is a brief theoretical exposition of the 16 critical success factor variables of business intelligence used in the research conceptual framework.

3.7.1 Clear Business Case and Vision

Yeoh and Koronios (2010) and Dawson and Van Belle (2013) emphasised the need to have a clear business plan and vision aligned to the IT strategy. The vision and mission of the project must also specify measurable goals and targets in terms of lowering costs, increasing revenues, increasing profitability, and improving business processes and competitive advantage. Organisations need to clearly state the problem match and know what they need from the BI system implementation to aid their business. Naderinejad et al. (2014) stressed the importance of a clear BI perspective, goals and strategy to drive the implementation initiative. Information systems research (Clark et al., 2007; Hostman et al., 2007; Wang et al., 2008; Kwon et al., 2006; Hartono et al., 2007) found that misalignment between the business objective and the information system is one of the major reasons for IS failures. Yeoh (2010) stressed that a BI initiative is driven by business, so a strategic business vision is needed to direct the implementation process. Lönnqvist and Pirttimäki (2006) emphasised the need to prove that business intelligence activities are worth the effort to justify the investment and help drive the initiative. Thus, a business plan is critical and should specify the benefits, resources, costs, risks and timeline.

3.7.2 Executive Sponsor

Dawson and Van Belle (2013) emphasised the need for a business side sponsor with authority and committed leadership to support the project and drive it from beginning to the end (Sarker & Lee, 2003). The executive sponsor is the business driver who actively supports the project and supplies it with various resources. Sammon and Finnegan (2000) viewed the project sponsor as the advocate of the project at the board, who would continually manage resistance and change. By appointing an executive-level individual with extensive knowledge of the organisation's operational processes, senior managers can buy into the project and support and monitor the project. Somers and Nelson (2001) noted that a project champion who understands the technology of the business and the organisation's needs should own the life of the project.

3.7.3 Top Management Support

Olbrich et al. (2012) and Dawson and Van Belle (2013) stressed the importance of top management support for the business intelligence implementation project. Slevin and Pinto

(1986) stressed that at the early stages of a project, no single factor is as predictive of its success as the support of top management. Top management must be willing to allocate valuable resources including financial and human resources to the project and communicate the corporate BI strategy to all employees. This has been stressed very strongly by researchers (Santhanam et al., 2000; Wixom & Watson, 2001; Hartono et al., 2007). Mensahand and Przanyski (2001) noted that project failures occur when senior management delegate progress monitoring and decisions at critical junctures of the project to technical experts. Yeoh and Koronios (2010) found that committed management support and sponsorship were widely acknowledged as being amongst the most important factors by the participants in their study. They stressed that management support was necessary to secure project funding, human skills, cooperation and other requirements for the BI initiative.

3.7.4 Adequate Budget and Resource

Naderinejad et al. (2014) and Olbrich et al. (2012) stressed the importance of adequate financial resources for the BI implementation project. Erickson (2003) noted that an information management system involves huge financial expense and there is therefore the need for an adequate budget to support the initiative (Humphrise et al., 1999). There are upfront costs for hardware, software and external consultancy costs, as well as on-going costs for annual licensing renewals, staff training, system security and administration. With regard to business intelligence systems, Moss and Atre (2003) noted that there are expenses for a centralised data repository or warehouse that requires a huge amount of data storage, high performance servers, and greater transmission bandwidth between the organisation's networks, which again are costly.

3.7.5 Nature of Organisations

The nature of an organisation in terms of size, structure, culture and whether it is private or public has also been highlighted as critical to business intelligence implementation (Dawson & Van Belle, 2013; Olbrich et al., 2012; Ramamurthy et al., 2007; Lapointe & Rivard, 2006). Ramamurthy et al. (2007), in a study of the key determinants of IS implementation success, noted that not only are larger organisations more able to afford resources to implement their IT system, they also have management processes in place to pilot the project to successful completion, including having training and post-implementation support. Culture for instance, defines the core beliefs, behaviour, shared values, norms and social customs that govern the way in which individuals act and behave in an organisation, including a strong corporate identity that is critical to facilitating change and new innovations. Lapointe and Rivard (2006), in a study on the adoption of computerised information system in Canadian hospitals, found that users' attitudes at various stages of the IS implementation varied from enthusiasm to neutral, which could lead to disruption and system withdrawals. They were of the opinion that the ability of the implementers to respond to resistance or antagonistic behaviour plays a critical role in IS implementation.

3.7.6 Project Management

Schwalbe (2000) talked of the "triple constraint" of project management: *scope, time*, and *cost*, which are often competing and interrelated goals that need to be managed properly in order to achieve project success. Proper project planning, scoping and execution to schedule are deemed to be crucial to IS implementation success (Naderinejad et al., 2014; Watson, Fuller & Ariyachandra, 2004; Baker & Baker, 1999). It is important to set the goals of the project even before seeking top management support (Slevin & Pinto, 1986). Many IS projects face scope creep, which has been identified as a common cause of project failure because of the lack of a clear project plan (Conner, 2003). Moss and Atre (2004) observed that the scope of a BI project could be staggered in such a way that a set of functions for a specific business sector could be delivered within a reasonable time, rather than waiting for one massive "big bang' solution that may not be completed on time and with the available resources.

3.7.7 Managing change and expectation

Research has found that effective change management is critical for the successful implementation of information systems and business process re-engineering (Naderinejad et al., 2014; Sangar & Iahad, 2013; Pedigo, 1998; Somers, 2001). Sangar and Iahad (2013) stressed that in the early stage of a BI project, change management is important to address reluctance. Appleton (1997) noted that project management significantly underestimated the efforts involved in change management, which in turn seriously undermined project success. He stressed that organisations should not only recognise the need for change to stay competitive, but they should also know how to manage change in order to succeed. Somers (2001), in a study of ERP systems, noted that the scope of the project needs to be defined clearly and any changes to the original plan should be controlled and managed. Part of change management is also managing expectation. Information system (IS) failure has been defined as *"the inability of an IS to meet a specific stakeholder group's expectations"* (Lyytinen & Hirschheim, 1987, p. 263). Thus, the ability to successfully manage user expectations in terms of the system's capability has been found to be related to successful system implementation.

3.7.8 Appropriate Team Skills

The project team should be balanced, cross-functional, and consist of both internal staff and external consultants (Naderinejad et al., 2014; Yeoh & Koronios, 2010; Baker & Baker, 1999; Sigal, 1998). Watson and Ariyachandra (2004) stressed the importance of technical skills and expertise for the success of an IS project, and particularly emphasised the degree of developer skills (Bajwa et al., 1998; Santhanam et al., 2000; Wixom & Watson, 2001; Hartono et al., 2007). Everett (2006), in a survey on service-oriented architecture (SOA) for business intelligence BI systems, found that only a third of respondents believed their internal IT staff had the knowledge and skills to implement BI as a service. Cornor (2003) found that many organisations have had to bring in outside consultants to bring stalled projects back on track because of lack of appropriate internal technical staff. Researchers have also highlighted the significance of bringing in people that not only meet the required levels of technical competence, but also understand the company's business requirements, processes, and distinct ways of working, which are essential for success (Bajwa et al., 2004; Somers & Nelson, 2001; Hammersley, 2000). Ruddy (2006) analysed the onsite\offsite mix of project teams and was particularly concerned about business knowledge. He stressed that to reap the full benefits of global implementation delivery, organisations must be aware of special considerations that can make BI more difficult to perform offsite than other technology disciplines. For example, BI implementations demand a significant amount of business knowledge and process that offsite resources may lack. Ruddy (2006) is of the view that organisations allow onsite resources to focus on high-value roles and project management that requires business knowledge, while offsite resources focus on development and maintenance activities.

3.7.9 Communication with Stakeholders

Slevin and Pinto (1986), in one of the earliest studies on information system (IS) project success, identified communication as a key component across all ten factors. They stressed that communication is essential within the project team, between teams, and with end clients including external consultants. Goals and expectations must be clearly communicated effectively among stakeholders and to all levels of employees who will be affected by the system. Regular communication through project highlights such as "where we are" and sharing project milestones, including informing staff of what happens next, will help staff to buy into the project. Any feedback offered by users must be seen as being received and acted upon (Summon & Finnegan, 2000), while interdepartmental communication and coordination is paramount, in particular for business intelligence systems with different data ownership structures and forms of retention (Hawkings & Pervan, 2008; Olszak & Ziemba, 2012).

3.7.10 Technical Infrastructure

Business intelligence system implementation is built on technical infrastructural resources. Moss and Atre (2004) emphasised that BI infrastructural resources, in terms of hardware, software and networking resources, must be adequate and scalable to accommodate future ICT requirements (Yeoh & Koronios, 2010; Dawson & Van Belle, 2013). Chem et al. (2012) noted that cloud computing and mobile devices are becoming increasingly important to modern business intelligence and self-service BI (Turban et al., 2011; Chang, 2014). Thus, carefully defined information and technical infrastructure system requirements are noted to be critical to the success of BI system implementation.

3.7.11 Architecture and Methodology

A well-defined technical architecture and implementation methodology have been identified as core to information system success (Naderinejad et al., 2014; Olbrich et al., 2012; Damianakis, 2008; Watson & Wixom, 2007). Key implementation methods to consider in this respect are proof of the concept, piloting and phased deployment (Atos & Moss, 2004). There are also architectural considerations to make in the implementation process around a de-centralised or centralised architecture, shared technical platforms, and BI front-end access methods, whether via the web, handheld mobile devices and or desktop PCs. Mobile devices like tablets and smartphones are now becoming part of contemporary BI deployment, and are easily accessible, although desktop access offers greater functionality and may be more suitable for specific users (Hostmann et al., 2007). The former may enhance BI usage and increase BI access, while the latter may offer richer and faster analysis, and more effective in decision-making opportunities. For some deployment, it might be a combination of both access methods. Olbrich et al. (2012) identified a business driven implementation methodology. Moss and Atre (2004) noted that business intelligence, unlike most enterprise deployment, requires a lot of coupling and integration of different middleware and front-end systems. Therefore an appropriate combination of architecture and methodology is noted as being crucial to business intelligence implementation success.

3.7.12 Data Management and Integration

Data for a BI system can come from a number of disparate data sources and in different formats. Therefore the data need to be extracted, transformed, filtered, loaded into an enterprise BI data repository and standardised. The data conversion can be even more difficult if the company does not understand what information it wants (Naderinejad et al., 2014; Watson, 2001; Hartono et al., 2007). Data must be available in such a way that it is usable. Data related issues have been known to be problematic, and the management of data conversion and standardisation are critical success factors in the implementation process (Artos & Moss 2004; Wixom & Todd, 2005; Clart et al., 2007). There is evidence that organisations of all sizes are negatively affected by imperfect, duplicate and inaccurate data (Damianakis, 2008). Furthermore, there is also the issue of data ownership, control and governance. Ruddy (2006) observed that organisations must make sure that appropriate security and privacy controls are in place when data are sorted offsite. Sangar and Iahad (2013) emphasised the importance of data and information accuracy, integrity and sustainability, as well as data quality and quantity for the success of a BI project (Yeoh & Koronios, 2010; Dawson & Van Belle, 2013).

3.7.13 Software Selection and Vendor Support

Business Intelligence enterprise implementation means making long-term commitment to software and architecture; thus choosing the right software that best matches the organisation's information needs is important. This process is critical to ensure minimal modification; successful implementation and continuous system use (Umble et al., 2006). Closely related to the above is the required technical support from the software provider (Yeoh et al., 2006; Wixom & Todd, 2005), as there will always be new software version upgrades. Consequently, vendor support, especially with packaged software, in the form of extended technical assistance, emergency maintenance, software fix updates, and user training is crucial. Jarvenpaa and Ives (1991) found that packaged software implementation success is positively associated with a good relationship between the software vendor and the user organisation, and stressed that organisations should manage and maximise their relationship.

3.7.14 User Training

The role of user training in implementation success is well documented in the IS literature (Nelson & Cheney, 1987; Santhanam et al., 2000; Hartono et al., 2007). Users need to be trained, not only in how to use the BI system, but most importantly, they need to understand how the application enhances business processes. A lack of appropriate training has been found to be responsible for negative software adoption by end-users and implementation failure (Hartono et al., 2007). Where consultants implement an IS system, knowledge must be transferred from the external consultant to the internal employees, and there should be opportunities to enhance skills continuously to meet changing business needs (Somers & Nelson, 2001).

3.7.15 User Participation

User involvement and feedback in the design of the information system has been found to be crucial in the information systems (IS) literature (Hwang & Thorn, 1999; Conner, 2003; Wixom & Watson, 2001; Olbrich et al., 2012; Dawson & Van Belle, 2013). Studies have indicated that a higher level of user participation leads to a higher level of system acceptance (Lapointe & Rivard, 2006). Yeoh and Koronios (2010), in their study on business intelligence CSFs, found that respondents were of the view that when users' opinions mattered during the project analysis stage, and they undertook different project roles and tasks, this led to better communication of their needs regarding the project and ensured system success.

3.7.16 User Intuition

Isik (2009) observed that one of the differences between BI and other types of information system is not just whether the BI system is used, but how it is used, which can have a major impact on the benefits derived. Therefore the characteristics of BI users, and their competencies and ability to harness and exploit the BI system, can have a disproportionate impact on the benefits derived from a BI system. Hostmann et al. (2007), echoing similar sentiments to Naisbitt (1982), stressed that user intuition is very important especially for a business intelligence system where there is a lot of data. Technology can provide notifications and monitor events, but for decisions requiring human thought, intuition is essential (Bell, 2007). Table 3.4 below presents a summary of the critical success factor variables used in the research conceptual framework.

Table 3.4: Summary of critical success factor variables

Critical Success Factors (CSFs)	Definition	Reference
Executive sponsor	Project champion, driver, senior executive who actively supports the project, represent the project at the board, provide guidance.	Somers and Nelson (2001), Sammon & Finnegan (2000), Wixon & Watson (2001), Hartono et al. (2007), Yeoh & Koronios (2010); Olszak, & Ziemba, (2012), Olbrich et al., (2012), Dawson & Van Belle (2013)
Top management support	Overall management support, commitment, willingness to allocate project resources, communicating corporate IT strategy.	Santhaam et al. (2000), Wixon & Watson (2001), Hartono et al. (2007), Nah & Delago (2006), Santhanam et al. (2007), Olszak & Ziemba (2012), Dawson & Van Belle (2013)
Clear business case and vision	Clearly defined business case, BI vision aligned to IT strategy, measurable costs, risks, resources, benefits and timelines	Clark et al. (2007), Hostman et.al (2007), Wang et at. (2008), Kwon et al. (2006) Hatono et al. (2007), Lonnqvist & Pirttimaki (2006), Yeoh & Koronios (2010), Harison (2012), Dawson & Van Belle (2013), Naderinejad et al., (2014)
Nature of organisation	Size, structure, whether private or public, type of business.	Ramanmurthy et al., (2007), Xu (2003), Mabert & Soni (2003), Olszak & Ziemba (2012), Olbrich et al., (2012), Dawson & Van Belle (2013), Naderinejad et al., (2014)
Adequate Budget	Adequate funding for hardware, software and human resources, committed budget, and possibly room for budget flexibility.	Sammon & Finnegan (2000), Wixon & Watson (2001), Moss & Atre (2004), Umble et al. (2006), Yeoh & Koronios (2010), Olbrich et al., (2012), Dawson & Van Belle (2013), Naderinejad et al. (2014)
Project management	Management of project scope, time, and resources, proper planning and scheduling, clearly defined project deliverables.	Barker & Baker (1999), Watson & Wixon (2001), Atre and Moss (2004), Little & Gibson (2003), Eckerson (2005), Yeoh & Koronios (2010), Olszak & Ziemba (2012).
Change Management	Clearly defined change management and control from origin, clearly defined scope, management of expectation, management of resistance to change.	Pedigo (1998), Somers & Nelson (2001), Little & Gibson (2003), Eckerson (2005), Arnott & Pervan (2008), Yeoh & Koronios (2010), Hawking & Sellitto (2010), Naderinejad et al. (2014)
Communication	Complete and open communication, interdepartmental communication and coordination, communication with all major stakeholders.	Slevin & Pinto (1986), Sammon & Finnega (200), Sarker & Lee (2003), Sammon & Adam (2005), Imhof (2004), Yeoh & Koronios (2010), Olbrich et al., (2012)
Project team	Appropriate technical skills, balanced, coordinated team, business knowledge, balance of offsite and onsite composition, team work.	Barker & Barker (1999), Sigal (1998), Wixon & Watson (2001), Watson, Fuller & Ariyachandra (2004), Hartono et al.(2007), Yeoh et al. (2006) Olszak & Ziemba (2012), Naderinejad et al., (2014).
Technical Infrastructure	Adequate hardware, software and network resources, compatibility and integration with existing tools.	Poon & Wanger (2001) , Wixon & Watson (2001), Moss & Atre (2004), Umble et al. (2006), Arnott & Pervan (2008), Dawson & Van Belle (2013), Naderinejad et al. (2014)
Data management and integration	Data extraction, conversion, transformation, loading, cleansing, flexible data models. Clearly defined data standards and governance, reliable, consistent and available data.	Wixon & Watson (2001), Poon & Wanger (2001), Hartono et al.(2007), Arnott & Pervan (2008), Olszak & Ziemba (2012), Yeoh & Koronios (2010), Dawson & Van Belle (2013), Naderinejad et al. (2014)
Software selection and vendor support	Appropriate software, access to technical support and training, management of third party and consultants.	Umble et al. (2006), Cooper et al. (2000), Conor (2003), Yeoh et al. (2006) Wixon & Todd (2005), Hawking & Sellitto (2010).
Implementation Methodology	Development and release methodology, prototyping, piloting, decentralised and or centralised architecture, access methods, flexibility to different technological needs.	Ross et al. (1996), Moss & Atre (2004), Damianakis (2008), Watson & Wixon (2007), Hostmann et al. (2007), Yeoh & Koronios (2010), Naderinejad et al. (2014)
User participation	User involvement, consistent user engagement, higher level of user involvement leads to higher user acceptance.	Hang & Thorn (1999), Santhanam et al (2000), Wixon & Watson (2001), Lapointe & Rivard (2006), Hawking & Sellitto (2010), Olbrich et al., (2012), Dawson & Van Belle (2013)
User training	System training to encourage usage, knowledge transfer and adaptation to enhance business processes, continuous user pedagogy.	Nelson & Cheney (1987), Santhanam et al (2000), Moss & Atre (2004), Hartono et al. (2007), Yeoh & Koronios (2010), Naderinejad et al. (2014)
User intuition and Competencies	User competencies and intuition, user characteristics and competencies, user ability to exploit and harness the BI system	Hostmann et al. (2007) Bell (2007), Isik (2009), Olszak & Ziemba (2012)

Source: Own

3.8 Development of Research Conceptual Framework

3.8.1 Background

The theoretical framework is the foundation upon which a research project is based. Routio (2007) noted that paramount to establishing the research design is the development of the research conceptual framework underpinning the investigation. It is the logically created, developed and elaborated network of associations existing between variables that have been identified through literature reviews to explain the object of study (Bryman & Bell, 2007). The research framework allows analogies to be studied and distinguished (Beranek & Newman, 1983). Initially, the research conceptual framework exists only as an idea in the research process, but quite often, by the end of the study, it becomes real in the form of a proposed research model, explaining the interactions and inter-relationships found in the object of study (Routio, 2007).

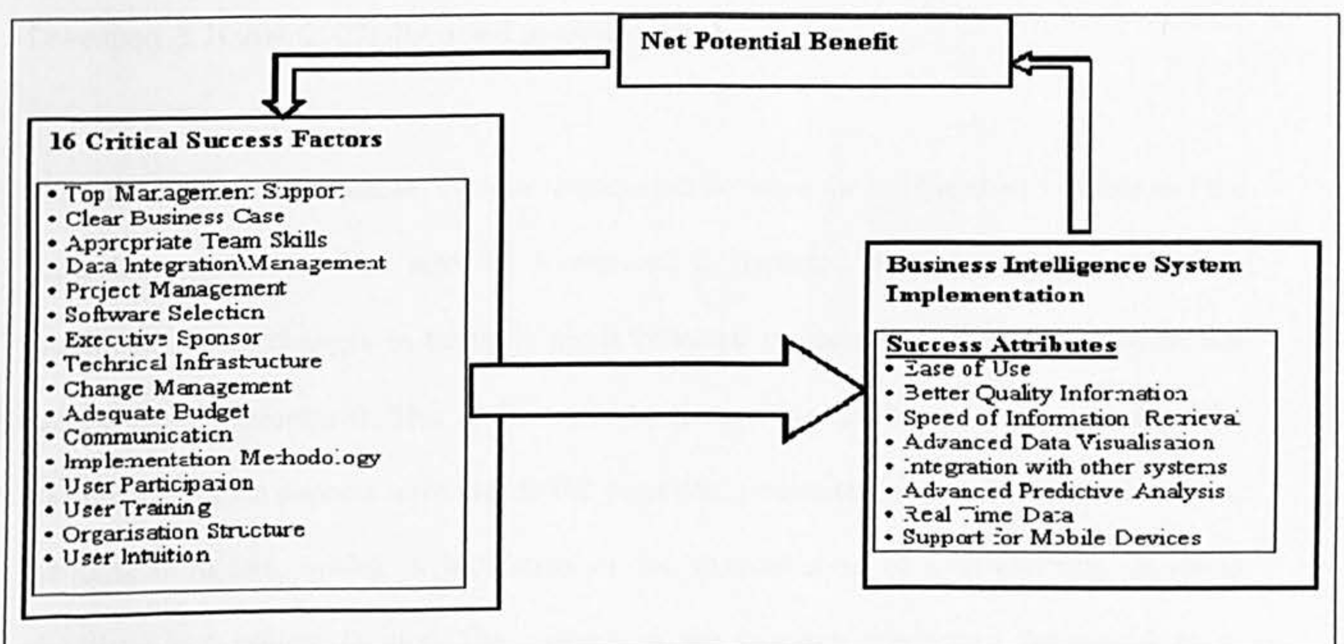
In this study, the initial research investigation revealed that business intelligence systems are expensive and complex to implement with many cases of failure (Hwang & Xu, 2007; Howson, 2008; Isik, 2009; Yeoh 2010). Yet, few empirical studies have been conducted, despite the fact that business intelligence systems have consistently appeared among top IT spending over the last few years (Gartner, 2011, 2012, 2013). To investigate the identified problem, the study developed an initial research framework.

The conceptual framework is grounded on theories of information system (IS) success (Deleon & McLean 1992; Deleon &McLean 2003; Venkatesh et al. 2003), critical success factors of information management systems (IMS) (Wixom & Watson, 2001; Hartono et al., 2007; Hawking & Sellitto, 2010; Yeoh & Koronois, 2010; Olszak & Ziemba, 2012; Olbrich et al., 2012; Dawson & Van Belle, 2013;), discussed in sections 3.2 - 3.5, and project life cycle management theories (Slevin & Pinto 1986; Antre & Moss, 2003), including theories and models that explain variable relationships such as Factor Analysis (Hair 2005; Field 2009). Beranek and Newman (1983) emphasised that in examining variable relationships, it is not enough to postulate that one variable influences another, but more importantly to establish by how much, which is a major quest of this study.

3.8.2. The Conceptual Framework

The research framework posits that to effectively implement a business intelligence system, organisations must: (1) understand the interdependent interrelationship between the critical success factors, (2) understand their relative importance, and (3) understand which critical factor relates to which BI success measure, and more likely to have the most impact on the realisation of that particular BI success objective. From a project management perspective, the model postulates knowing how to manage the criticality of the success factors and knowing how to manage the BI benefit outcome. The research frameworks and the major component parts with their possible interrelationship are illustrated in Figure 2.10.

Figure 3.2: Research Conceptual Framework



Source: own.

The first component is the set of 16 critical success factors, which are the independent variables. These CSFs were derived through a process of identification, iteration and ranking of the related literature discussed in section 3.8.

The second component is the dependent variable, which is BI system implementation success discussed in section 3.6. For purpose of this investigation, the major quality themes of BI success were further qualified into eight BI success attributes, namely: *Data Quality* (better quality information, real time data analysis); *System Quality* (speed of system responsiveness, advanced visualisation, advanced predictive analysis, support for mobile BI); and, *Usage Quality* (easy to use, ability to integrate with other systems).

The third component in the model is the *Net Potential Benefit* that is expected from the use of the business intelligence system, such as: aiding better decision-making, increasing business competiveness, enabling efficiency savings, and increasing business profitability.
The BI success qualities and attributes were derived from the information systems literature (DeLone & McLean, 2003; Wixom & Watson, 2001; Shin, 2003; Hwang & Xu, 2007; Davenport & Harris, 2007) discussed in section 3.6.

The horizontal arrows indicate a linear relationship between the independent variable and the dependent variables. The research framework is dynamic, flexible and presupposes a progression, with changes in business needs reflected in changes in corresponding critical success factor antecedents. This is illustrated by the continuous flow of the arrows from the BI implementation success attributes to the perceived potential business benefit, and back to the critical factors, which is indicative of the re-evaluation of ever-changing business objectives and critical factors. The essence of the research conceptual framework is to provide a focus for the empirical investigation of data gathering and analysis in addressing the research questions.

3.9 Chapter Summary

This chapter provided a critical literature review of the arguments, theories and models of information system (IS) success and critical success factors (CSFs), grounded in general theories of information management system research. It then focussed on what these meant for business intelligence implementation success. A critical review of the literature identified different positions and thoughts on the issues. Different critical success factor variables were used in studies depending on researchers' perspectives. The findings and conclusions were fragmented and isolated, and it was difficult to identify a common set of variables.

Furthermore, the relationships between critical success factor variables have not been well-explored. Certainly there are gaps in the BI implementation literature that need to be investigated. Subsequently, the chapter proposed a set of 16 CFS variables for the development of the research conceptual framework. These CSFs were chosen through an iterative scoring process of most reoccurring CSF factors variables found in BI and similar IMS research. This set the stage for the next chapter, which describes the research method and design for the data collection and analysis.

CHAPTER FOUR: METHODOLOGY AND RESEARCH DESIGN

4.1 Introduction

This chapter provides a detailed outline of the research design and methods used for data collection and analysis. It also discusses the theory and research philosophy underpinning the choice of method and research design, to help understand the rationale for undertaking certain activities. But first, it is important to distinguish some common interchangeably terms used in this study, namely: research method, research design and research methodology.

Research method refers to the actual tools and techniques used for data collection and analysis, such as questionnaires, interviews, participant observation records and others (Bryman & Bell, 2007; Gupta, 2003). Guiding the choice of research methods is the research design. This is the framework under which the research is actually conducted, whether it is a survey, a case study, or a longitudinal or comparative study (Dobson, 2002). Kumar (2005) defined the research design as a procedural plan adopted by the researcher in answering the "*research questions validly, objectively, accurately and economically*" (p.84).
The research methodology is used in a wider context to include the theories and philosophical assumptions underpinning the research design and choice of methods (Fisher, 2004; Adams et al., 2007). Bryman and Bell (2007) noted that the research design, methods and philosophical assumption are intractably linked with the latter fashioning the others.

Thus, the first part of this chapter deals with the research philosophical background, while the second part discusses the research design and the actual techniques and tools used for the data collection and analysis. The third part discusses issues of research quality involving reliability and validity, as well as ethical considerations and how these were addressed in this research.

4.2 Research Philosophy

Research is a quest to examine and explain a phenomenon in one or more ways. Research looks for explanations, comparisons, relationships, predictions, generalisations and theory building (Phillips and Pugh, 2000). Research increases the sum of what is already known, and also allows for further investigation (Blaikie, 2007). The question of what is known, how it is known and the assumptions underlying "knowledge", is generally referred to as the research philosophical paradigm of epistemology and ontology. This is very important and is integral to the validity of the research (Dobson, 2002; Bryman & Bell, 2007).

Epistemology is the study of how we came to know what we know. Blaikie (2007) defined epistemology as *"the theory of how human beings come to have knowledge of the world around them"* (p.18). Ontology, on the other hand, refers to the researcher's philosophical assumptions regarding social reality, whether the object of investigation is observable and measureable and which tools are appropriate. Burrell et al. (1979, p.1) noted that *"ontology concerns the very essence of the phenomenon under investigation"*.

Epistemology is related to ontology as it addresses the issues and assumptions of how we came to have that knowledge of reality. Ontology and epistemology are intertwined into two major poles of research paradigms, namely: positivism and constructivism, with realism as the middle ground (Neil & Nasi, 1980; Guba & Lincoln, 1994; Krauss, 2005; Bryman, 2006). Although other research paradigms exist, for example critical social science, post modernism etc., positivism, interpretivism and realism are the three major research approaches. The next section explores each of these research paradigms independently, in order to understand the rationale for the choice of the research philosophy.

4.2.1 Positivism

The positivist researcher adopts a concrete concept of observable social reality similar to the laws of natural sciences. Positivist ontology contends that reality is external and observable, and can be measured objectively, not through reflection and intuition (Easterby-Smith et al., 2002; Saunders et al., 2003). Methodologically, positivists adopt deductive, deterministic and quantitative research techniques and view the object of study as independent of the researcher. The positivist researcher collects empirically verifiable data that can be rigorously tested in order to derive generalisable propositions that lead to model or theory building.

4.2.2. Constructivism

Constructivism is the contrasting research philosophical paradigm to positivism, and also referred to as interpretivism. For the purposes of this thesis, both terms are used interchangeably. Constructivists adopt a subjective construct of observable social reality and view the social world as too complex to theorise according to laws similar to those found in the natural sciences (Saunders et al., 2003). Interpretivists opine that knowledge is what individuals perceive, and is established through meanings attached to phenomena. Thus, there is no single reality; rather "multiple realities" exist for a single phenomenon based on the researcher's assumptions (Krauss, 2005). Constructivists argue that the norms, beliefs and value systems that individuals hold, influence their interpretation of reality and how people view reality. The combination of these, Fisher (2004), describes as socially constructed reality. Methodologically, constructivists adopt an inductive and qualitative research approach, and view the researcher as playing a major role in the outcome of the investigation. A typical feature of constructivist research is the in-depth analysis and interpretation of qualitative data, including the importance of other social constructs such as language, attitude and cultural objects in making meanings (Silverman, 2005). This implies a process where observations and patterns precede theory, which contrasts with the positivist approach, which relies more on testable hypotheses and deduction. Thus, whereas positivists try to explain human behaviour by an attempt to generalise, which they aim to achieve with large samples, the constructivist try to understand individual behaviour in greater depth, which they hope to achieve with small in-depth case studies (Bryman & Bell, 2006).

4.2.3 Realism

The alternative to the positivist or constructivist research paradigms is the realist or pragmatist, paradigm. Realists share the positivists' belief that reality exists outside the phenomenon, is independent of human thoughts and beliefs and is measurable (Saunders et al., 2003). However, realists also accept the interpretivists' belief that human beings are not merely scientific objects that can only be studied and measured, but also hold socially constructed beliefs that impact on their behaviours and interpretations of events (Saunders et al., 2003). Thus, realists make a less ambitious attempt than positivists would normally do to confirm and measure true knowledge, since some social and human phenomena are context dependent. Nonetheless, realists attempt to label and measure certain phenomena, taking into account the social forces that may affect any resulting findings (Fisher, 2004). Methodologically, realists adopt a mixed methods research approach, employing qualitative and quantitative techniques that best suit the research question. Proponents of mixed methods research (Krauss 2005, p.765) see it as an essential middle ground *"between the poles of positivism and constructivism that triangulates elements of both rather than solely one or the other"*. In fact, Guba and Lincoln (1994) noted that despite the many professed differences between quantitative and qualitative epistemologies, ultimately, the heart of the quantitative-qualitative "debate" is philosophical, not methodological. Perhaps this is why

Klein et al. (1991) called for tolerance of methodological pluralism in recognition of personal bias associated with methods. In practice, most social science research includes elements of inductive and deductive approaches at different times during the investigation (Saunders et al., 2003; Easterby-Smith et al., 2002; Bryman & Bell, 2007).

The essence of the above exposition is to prepare the background, and to clearly articulate and define the ontological and epistemological perspective underpinning this research (Guba, 1985; Krauss, 2005; Bryman & Bell, 2007). Table 4.1 below illustrates the levels of the research approach continuum.

4.3 Methodological approach to existing BI studies.

Although there exist plenty of anecdotal studies and guidelines for BI implementation, there are few empirical studies, as discussed in section 3.5. This is perhaps due to the relative newness of BI as a field of study compared to well-established disciplines. However, even the few empirical studies that do exist (Hawking & Sellitto, 2010; Jamaludin & Mansor, 2011; Olszak & Ziemba, 2012; Harison, 2012; Olbrich et al., 2012; Dawson & Van Belle 2013; Sangar & Iahad 2013; Naderinejad et al., 2014) have a common methodological perspective. The researchers have adopted the constructivist qualitative case study approach, and the Delphi technique also seems to be a popular approach in their investigations (Yeoh et al., 2007; Yeoh & Koronios, 2010; Olbrich et al., 2012; Dawson & Van Belle, 2013).

Thomas Grisham (2008) noted that although the Delphi technique is well suited to researching complex issues where larger scale quantitative "hard data" fails to unearth richness in tacit knowledge, the *"Delphi technique is however a qualitative approach and not a quantitative approach and may not produce robust numerical accuracy that yields exact repeatable results"* (p.125). Wanda et al. (2004) indicated that the primary purpose for the adoption of the Delphi technique is inductive, although Garson (2014) has highlighted some quantitative and deductive uses of Delphi data. Furthermore, while the qualitative\inductive approach provides an in-depth understanding and richness in the research outcome, there is a general concern regarding generalisability beyond a single case or a few cases (Yin 1994). Thus, perhaps, there is a need to extend research by applying different techniques that can enrich the overall body of knowledge in the field of business intelligence.

Table 4.1: Methodological Approach to Existing BI Studies

Year & Author	Title of Study	Methodology
Yeoh & Gao (2006)	*Critical success factors for the implementation of business intelligence system in engineering asset management organizations.*	Delphi delimitated interview case study - Qualitative
David Arnott (2008)	*Success Factors for Data Warehouse and Business Intelligence Systems*	Longitudinal interview case study - Qualitative
Yeoh & Koronios, (2010) (from earlier work)	*Critical Success Factors for Business Intelligence System*	Delphi delimitated interview case study Qualitative
Hawking &Sellitto (2010)	*Business Intelligence (BI) Critical Success Factors*	Inductive interview case study - Qualitative
Olszak & Ziemba (2012)	*Critical Success Factors for Implementing Business Intelligence Systems in Small and Medium Enterprises on the Example of Upper Silesia, Poland.*	In-depth interviews case study using critical thinking and inductive reasoning - Qualitative
Harison (2012)	*Critical Success Factors of Business Intelligence System Implementations: Evidence from the Energy Sector*	Inductive interview case study - Qualitative
Olbrich et al., (2012)	*Critical Contextual Success Factors for Business Intelligence: A Delphi Study on Their Relevance, Variability, and Controllability.*	Delphi delimitated interview case study - Qualitative
Dawson & Van Belle (2013)	*Critical success factors for business intelligence in the South African financial services sector*	Delphi delimitated interview case study - Qualitative
Sangar & Iahad (2013)	*Critical Factors That Affect The Success Of Business Intelligence System (BIS) Implementation In An Organisation*	Inductive interview case study - Qualitative
Naderinejad et al., (2014)	*Recognition and Ranking Critical Success Factors of Business Intelligence in Hospitals - Case Study: Hasheminejad Hospital, Iran.*	Survey using LISREL-Quantitative

Source: own.

4.4 Methodological Approach to this study.

The study's epistemology is grounded on the theory of the existence of critical success factors of Information System implementation (Hurly & Harris, 1997; Sammon & Finnegan, 2000; Wixom & Watson, 2001; DeLone & McLean, 2003). Its quest is how particular critical success factors influence the outcome of business intelligence system implementation. The study reflects on the ontological assumption that business intelligence implementation success is a factor of both observable and measurable constructs, and unobservable and immeasurable constructs. This research seeks to answer the question of "what", the "level of criticality", "why" and "how" in understanding the process of BI system implementation. The assessment of the "what" factors, and their "level of criticality" with regard to the research variables are more measurable constructs that require the use of a quantitative method. The "how" and "why" questions in relation to understanding the process of BI implementation in organisations, involve making meaning, inferences, and inductiveness; which are less measurable and necessitate the use of qualitative methods (Bryman, 2007).

Therefore, a realist methodological approach that triangulates quantitative and qualitative techniques is adopted for this study. Jo Moran-Ellis et al. (2006) defined triangulation as *"the potential for knowing more about a phenomenon through the use of different research techniques in one empirical investigation"* (p.46). Triangulation as a term is borrowed from navigation, where a minimum of three reference points are used to check an object's location (Smith, 1975). It has been applied in social science research in the triangulation of theories, where theories from another discipline are used to explain a phenomenon. The triangulation of data where data are collected independently by researchers from different sources or over different time frames on the same subject, and findings are then compared to explain a phenomenon; or triangulation of analysis which entails the use of different techniques to analyse the same data set to explain and verify a phenomenon (Denzin, 1988). Kaplan et.al (1988), in a study combining qualitative and quantitative methods in information systems research, noted that triangulation *"increases validity"*, which comes from unavoidable bias if only one method is used. They stressed that, *"mixing methods can lead to new insight and models of analysis that are unlikely to occur if one method is used alone"* (p.582). In the same vein, Bryman (1996) noted that research is enriched by the addition of other, different techniques to the tool basket, as this allows for a holistic picture to develop.

In this study, triangulation of the data and analysis was achieved through an initial literature review, followed by a self-completed survey questionnaire to verify the research variables, combined finally with an in-depth case study to get a deeper insight into the process of BI implementation. The next section discusses the detailed research design and techniques of data collection and analysis.

4.5 Research Design

This study's research design is determined by the research question and objective, underpinned by the realist philosophical paradigm as articulated in Section 3.4 above. Yin (2003) defined the research design simply as the "blueprint" that guides the researcher. It deals with what questions to investigate, what data to collect, what procedures and tools to use for measurement, and how to analyse the results (Yin, 2003; Bryman & Bell, 2007).

The phenomenon of business intelligence implementation is a contemporary practical business challenge and one of the motivations for this study was to explore the critical success factors CSFs that influence BI system implementation, and how the phenomenon is undertaken in a real-life setting. Zmund (2000) defined exploratory research as that which is undertaken to clarify and gain an insight into the nature of a vague problem. Saunders et al. (2003) explained that exploratory studies *"tend to start with a wide research area, and narrow down as the research develops"* (p.42).

Therefore, the empirical research design of this study consists of two stages: (a) a questionnaire survey, and (b) a semi-structured interview case study. The essence of the survey is to confirm and validate some of the initial research constructs from the literature review stage with professionals who have experience of BI implementation in their organisations. The case study will elicit a greater understanding about how the process is enacted in a real-life setting. While the survey data provided an assessment of the importance and relatedness of CSF elements to the BI project success and guided the formation of the research proposed model, the case studies explored the process and challenges, and how the critical success factor elements are actually addressed to engender the level of effectiveness needed to bring about the success of a BI project. Thus, the case study complements and supports the survey results.

The next section discusses in detail the techniques of data collection and analysis employed in the two empirical stages.

4.5.1 Survey Stage

4.5.1.1: Justification

This study aims to develop a success model for business intelligence implementation based on integrated perspectives. This requires not only investigating specific cases, but also examining larger samples to enable generalisation and model building. Collins and Hussey (2009) noted that surveys are designed particularly for this purpose, and that they are very popular strategy in management and business research. Saunders et al. (2003) defined the survey as a strategy that allows the collection of a large amount of primary or secondary data from a sizeable population to test propositions. Bryman and Bell (2007) noted that survey research could be highly economical. They noted that the data obtained are very suitable for statistical analysis, allow for easy comparison and can be used for, exploratory, explanatory, confirmatory, casual, and/or analytical research. Remenyi et al. (1998) noted that the survey provides a relatively simple and straightforward approach to the study of attitudes, values, beliefs and motives, and it allows information to be generalised from almost any population. Finally, the survey can encourage frankness and openness especially in relation to sensitive issues or questions (Robson, 2002; Neumann, 2004).

However, there is concern that the data collected could be affected by the participants' characteristics, such as their memory, knowledge, experience, motivation and personality (Neumann, 2004). There are also concerns that the participants may not accurately reflect their beliefs and attitudes in the surveys, and there is the possibility of ambiguity in for the answers that the participants may not have an opportunity to clarify (Robson, 2002). Survey research has also been noted as having a low response rate and that the participants may not take the survey questions seriously (Saunders et.al, 2003; Neumann 2004; Bryman & Bell 2007). But generally, survey studies are perceived to be reliable and they have been employed in critical factor studies in information systems research (Wixom & Watson, 2001; Chatterjee et al., 2002; Hwang & Xu., 2008; Hartono, Santhanam & Holsapple, 2007).

The survey strategy adopted in this research addresses the structural questions of: a) the degree of criticality of the success factors; b) the strength of the relationship between the critical success factors; and c) the impact analysis of the CSFs on business intelligence implementation success. The aim is to contribute to the development of a proposed model of business intelligence implementation success, and to confirm or refute some of the initial literature review findings.

4.5.1.2 Questionnaire Design

Collins and Hussey (2009) defined the questionnaire as a *'method for collecting primary data in which a sample of respondents is asked a list of carefully structured questions with a view to eliciting reliable responses' (p.192).*

In designing the questionnaire for this study, a number of considerations were taken into account such as: the question theme and wording principle, the page layout, the data definition, scaling and time to complete. In designing the questionnaire, the researcher used ideas from related information management research and adapted them for this research (Hwang & Xu, 2007; Chow & Cao, 2007; Wan & Wang, 2010; Henschen, 2012).

4.5.1.2.1 Theme and Wording Principle.

The theme of the questionnaire was critical success factors of business intelligence implementation, and the questions were organised across five broad areas. The first set of questions asked for background information including the respondent's profile, their organisation, their experiences with BI systems, the profile of the BI functionalities and technologies implemented, and how long the BI implementation took. The second set of questions was related to the key issue, "critical success factors of BI implementation". Here respondents were asked to rate the CSFs on a five-point Likert-based scale (1 to 5) ranging from 'not very critical' to 'very critical', respectively. A typical question was "how important is an executive sponsor to the BI implementation success"? In the third section, the respondents were asked to rank the BI success attributes that they consider important to their perception of implementation success such as: easy to use, mobile BI, advanced predictive analysis etc., again on a five-point Likert scale. A similar approach had been used in critical success factor studies in information management studies (Wixon & Watson, 2001; Hwang & Xu, 2007; Henschen, 2012). In the fourth section, the respondents were asked whether their BI implementation was undertaken by an internal team, outsourced to a third party BI specialist company or a combination of both. They were also asked to rate the overall success of their BI implementation. Finally, there was a section in which the respondents could make additional comments and include their contact details if they wanted to see the executive summary of the research (see questionnaire in Appendix 6).

Furthermore, careful consideration was given to the clarity of the wording and simplicity, including the clarity of the instructions, and using short and purposeful questions; negative and double-edged questions were avoided. The participants were asked for their consent and were made aware that anonymity and confidentiality were guaranteed (Frazer & Lawley, 2000; Gillham, 2002; Collins and Hussey, 2009).

4.5.1.2.2 Layout Considerations

Considerable attention was given to the questionnaire layout, format and tabs including the border shadings. These considerations were necessary in order to make the questionnaire more user-friendly and easy to read. The actual process of designing the questionnaire was carried out using the computer assisted questionnaire software, *Qualtrics* (http://kingston.qualtrics.com), designed and recommended by the Kingston University Business School. The page was divided into sections according to theme and presented in a logical order to build a sense of continuity. Different fonts were used to indicate question headings in order to provide a neat and professional finish to the questionnaire. Tick boxes were used to make answering the questions easy. There was an introductory message explaining the purpose of the questionnaire and an indication of the time it may take to complete. The message also stressed participant confidentiality and thanked them in advance for their time and effort (Frazera & Lawley, 2000).

4.5.1.3 Data Definition and Measure

Nominal and ordinal scales were used as measurements in the survey data as this addressed the needs and requirements of the research. A nominal scale with numeric codes was used to identify named categories, while an ordinal scale with numeric codes was used to rank the categories (Hair et al., 1987). As indicated, the study used a five-point Likert scale for simplicity and clarity. Although a seven-point Likert scale exists and may gather more detailed data, it can also introduce unnecessary confusion into the survey. Whereas a three-point scale was considered too restrictive and would not truly represent the population's attitudes. Likert scales do not measure attitudes per se, but represent the strength of the respondent's view in relation to others in the population, thereby forming a picture of the overall attitudes of the population (Kumar, 2005). It is important to point out that there are debates in the literature regarding whether Likert scales generate interval or ordinal data, and whether to adopt a parametric or non-parametric statistical test (Neumann, 2004; Carifio & Perla, 2008; Murray, 2013). This study adopted parametric statistical testing techniques in line with similar studies on information management systems that have used a Likert scale (Hwang & Xu, 2007; Chow & Cao, 2008). An important element of the quantitative study is that by presenting all of the respondents with the same standardised questions and using the same measure, it is easier to test for validity and reliability using different techniques (Robson, 2002; Sekaran, 2003).

4.5.1.4. Pilot Testing

To ensure the clarity of the questionnaire, its presentation and layout as well as the alignment of the survey questions with the research objectives, the questionnaire went through a number of iterations of pilot testing. Bryman and Bell (2007) noted that pre-testing is paramount before administering the questionnaire as it helps to detect possible shortcomings in the design. Neumann (2004) argued that pilot testing ensures clarity and increases the reliability of measures and replication of tools used. Remenyi et al. (1998) noted that approaches to pre-testing a questionnaire can either be fairly informal, where one consults professional colleagues and people with diverse opinions who are familiar with the subject of study, or they can be more formal, involving a pilot study on a small scale. This study undertook three rounds of questionnaire pre-testing.

The first round was with an expert tutor in research design and methods, who taught the questionnaire design module on the doctoral programme. A copy of the questionnaire was requested by the tutor, who then circulated it to other doctoral student colleagues for them to make comments. Following subsequent module sessions, the questionnaire was discussed with regard to its clarity, purposefulness, wording etcetera.

The second round of questionnaire testing was with the supervisory team. The team commented on the clarity, layout and wording and the alignment with the research objectives. Following these exercises, a number of amendments were made with respect to the sequencing of the questions, their clarity and relatedness and the overall design and modification of the questions.

The final round of pilot testing was conducted on a sample of the target population. Convenience sampling was used (Remenyi et al., 1998). It was considered that ten respondents was a sufficient number for pilot testing purposes (Fink, 1998). Prior to the final round of pilot testing, the researcher contacted each of the respondents and briefed them on the objective of the exercise. The final pilot participants were professional colleagues of the researcher working in the IT industry, who were familiar with the subject of information management systems implementation. In total, about twenty questionnaires were sent out, of which ten were returned. The researcher asked that they provide honest and critical feedback on the overall design, including the clarity, layout, presentation, timing, ease of completion and measurement scales together with any other comments they may wish to make. The final feedback was then used to make minor and necessary further adjustments and modifications before the questionnaires were administered.

Below is the pilot testing guide that was used for the study.

Table 4.2 Pilot testing guide.

Language	All language clear and easy to understand
Layout	Easy to follow
Clarity	Clear instructions and terminology
Presentations	Professionally presented
Ease of completion	Tick boxes and shading welcomed Requested to add scale at the top of every section
Sequencing	Logical order of sections
Length	Generally viewed as being long but removal of any questions could not be justified methodologically
Time taken to complete	Most completed within 10-15 minutes.
Covering Letter	Reflective of survey purpose
Other	No other comments

Source: Own. Derived from (Bryman & Bell, 2007; Hawson, 2009)

4.5.1.5. Sampling

The major sample selection criteria for the actual survey were: a) respondents' role, b) years of experience with BI, and c) UK based organisation.

Thus, the sample frame for the study was professionals who had experience of implementing a BI project in a UK-based organisation, such as chief information officers CIOs, business intelligence managers, BI project managers, BI solution\technical architects and experienced business intelligence users and analysts, who were familiar with the process of business intelligence implementation in their organisations. Given the fact that there is no comprehensive list of organisations and BI professionals that have implemented business intelligence systems, different methods were used to generate the sample.

Firstly, the researcher searched online for lists of major BI intelligence software providers such as Microsoft, IBM, Oracle, SAS, SAP, Business Objects, MicroStrategy, IMGroup; Kognito, Qlikview, among others, to generate a contact list of their United Kingdom based customers or clients that had implemented their version of BI software. There were a number of online customer testimonies with names and position of their UK based customers, and a list of these people was then compiled to make the sample frame and they were sent the study questionnaire (www.oracle.com/us/solutions; www.sap.com/uk; www.sas.com; www.microstrategy.com; www.microsoft.com; www.teradata.com; www.imgroup.com; www.kognitio.com; www.qlikview.com).

The second sampling channel employed involved business intelligence professionals registered with professional bodies such as the UK Data Management Association DAMA, who have experience of implementing BI systems. The study formally solicited the assistance of DAMA, who obliged and asked that an executive summary of the study's findings be sent to them for consideration for publishing in their monthly industry journal. The questionnaire was sent to DAMA and they sent it to their members.

The third distribution channel pursued by the researcher was industry magazines such as the ***Chief Information Officer (CIO),*** a magazine published in the United Kingdom. The researcher compiled and the sent the questionnaire to the top one hundred Chief Information Officers of major UK organisations as published by the magazine in two subsequent years (*CIO 100 2011, and CIO 100 2012*).

Finally, the researcher also attended a couple of IT conferences on Business Intelligence and Big Data Analytics in London that attract BI professionals from different organisations. One of the researcher's supervisors also attended one of the IT industry conferences with the researcher, which was encouraging. The researcher made a contact list of the conference speakers, who were then sent the questionnaire. A similar approach has been adopted in information systems research and was found to be productive (Yeoh & Koitosis, 2010). The IT conferences attended were:
(a) MicroStrategy Incorporated Business Intelligence Conference; 30 October 2012 London, organised by MicroStrategy UK Limited; www.microstrategy.co.uk; (b) Data Warehouse & Business Intelligence 14th Annual Conference Europe 2012, 5-7 November 2012, London UK, organised by, IRM UK Ltd; http://www.irmuk.co.uk/events/conferences.cfm; (c) Big Data Analysis Conference, BDA June 2013; 20 June; organised by Whitehall Media Ltd. http://www.whitehallmedia.co.uk

These conferences offered the opportunity for the researcher to exchange of ideas with industry participants, familiarise himself with new developments in the business intelligence industry and they also enabled the researcher make contact with possible interview and survey participants. In fact the researcher met three of the case study participants at these industry conferences.

4.5.1.6 Questionnaire Administration and Sample Size

The study adopted three strategies to administer the questionnaires. These were: a) posting out the questionnaire, b) making the questionnaire available online, and c) physically handing out the questionnaire at BI conferences and exhibitions, although it must be pointed out that the latter did not achieve many results as it was discouraged by the conference organisers.

Online questionnaires offer the great advantage of being easy to fill out and less time consuming for the respondents. They also cost far less compared to postal questionnaires, offer a faster response rate, and make the data collection and analysis processes easier (Collins & Hussey, 2009). Web-based surveys offer automatic coding of the responses, which can be easily downloaded to a spreadsheet or statistical data analysis package, thereby avoiding manual data entry. To encourage response, the survey package included an introductory letter, the survey questionnaire, and a pre-paid return envelope, including the URL link of the Web-based version of the survey. The inclusion of a pre-paid envelope is a way to promote responses as it ensures that the respondents do not have to incur any costs to participate in the survey. The questionnaires were printed on coloured paper as a way of capturing the respondents' attention and encouraging completion (Collins & Hussey, 2009). Where possible, most of the questionnaires were addressed directly to a named person or to a title of a key person involved in business intelligence implementation in organisations such as the Chief Information Officer (CIO), Business Intelligence Manager, Head of Information Technology or equivalent. To boost the number of responses, a follow-up questionnaire was sent to those who had not replied within a month and the respondents were also promised a copy of the key research findings and an executive summary report if they completed the questionnaire contact section. In total, 780 questionnaires were administered, of which 102 were returned, representing about 13 percent of the questionnaires sent. This is considered satisfactory in business and social science research (Jankowicz, 2000; Moffett et al., 2003). It should be mentioned at this juncture that there are opinions regarding adequate sample sizes with respect to statistical techniques such as factor analysis used in this study. In the literature, there are generally two recommendations: one emphasises an absolute minimum number of cases (N), while the other emphasises the cases-to-variables ratio (N: X). Gorsuch (1983) and Kline (1979, p.40) recommend at least 100 cases. Hatcher (1994) and Hair et al. (2003) recommend that the data for factor analysis should not normally be less than 100 samples or there should be an appropriate sample\variable ratio of 5:1.

In this study, there are 16 variables, and 102 survey data samples were returned, giving a variable\sample ratio of 1:6, thus satisfying both the numeric and sample\variable data criteria (Hair et al., 2003). The survey results are discussed in chapter five, the quantitative data analysis section.

4.5.1.7 Survey Data Management and Analysis Techniques

In this study, the quantitative data management encompassed the processes of data screening, editing, cleansing, loading and coding, which were carried out before the data analysis stage. Field (2005) emphasised the importance of this stage in ensuring that data is well-structured and organised, to aid the analysis, interpretation and confidence in the outcome. Prior to the actual data input, measurement variables were created and loaded into the SPSS system. Once the variables had been set, data input of the questionnaire responses began. To ensure data consistency and completeness, all of the responses were inputted logically and consistently in accordance with the question asked, and uncompleted questionnaires were not used. This is a very important stage in the data management process, as it eliminates omissions and errors, and ensures the reliability of results (Field 2005). The data management and analysis stage was aided by the use of Statistical Package for Social Scientists (SPSS) version 21, which Cramer (1998) describes as one of the most comprehensive and flexible statistical software tools, and is widely used.

The study adopted three main statistical techniques to analyse the survey data: a) descriptive statistics; b) factor analysis; and c) bivariate correlation analysis.

4.5.1.7.1: Descriptive Statistics

Field (2005) and Pallant (2007) noted that descriptive statistics should be the first step of any statistical analysis. This they noted is useful to provide an initial demographic insight into the data and sample population.

Descriptive statistics in the form of percentages, graphs, frequencies and Chi-Sqaure were used in this study to gain an initial understanding of the demographics of the survey respondents and their organisations, including the profile of the implemented BI solution. The objective was to obtain a comprehensive picture of the profile groupings and allow comparison between the groups.

4.5.1.7.2: Factor Analysis

Two major objectives of this study were: a) to explore the relationship between the critical success factors, the dependent variables; and b) to examine to what extent the CSF explains the BI implementation success, the independent variable. Exploratory factor analysis (EFA) was deemed suitable for the research purpose and it has been used in similar studies on IMS (Watson, 2001; Hwang & Xu, 2007; Henschen, 2012).

Factor analysis is a multivariate statistical technique that examines the underlying structural pattern among research variables to identify a common set of dimensions. Rummel (1988) noted that factor analysis has many uses among which are: understanding data interdependency and pattern delineation; parsimony or data reduction; understanding the basis structure of data domain; classification or description of the data; scaling; hypothesis testing; data transformation; data exploration; and theory building.

A reason for choosing this technique is that as an advanced multivariate statistical technique, factor analysis has the superior advantage of not only reducing data variables, but also handling the problem of multi-collinearity, which is common in standard multiple regressions and can make the interpretation and conclusions arising from such techniques unsatisfactory and questionable, (Costello et al., 2005; Hair et al., 2006). It does this by reducing the dataset of a group of interrelated variables to smaller clusters of uncorrelated variables or factors that can then be used in further regression (Hair et al., 2006).

Factor analysis is also used in this study to determine the covariates of the CSF variables, and by implication, understand their interrelationships and furthermore, identify sets of critical success factors that influence each other and might work better together for greater effect. It should be stated that factor analysis as a statistical technique is not without controversy (Williams et al., 2010; Beavers et al., 2013), not least because of its complexity and the series of iterative steps, which are undertaken and analysed in Chapter five of the survey results.

4.5.1.7.3: Bivariate Correlation Analysis

Bivariate correlation analysis is used in this study to examine the relationship between each critical success factor and BI implementation success attribute pair. Correlation analysis examines the strength of the relationship between the two research variables (Field, 2005). The aim here is to identify the sets of resulting CSFs from the initial exploratory factor analysis (EFA) stage that are most likely to influence the realisation of a particular BI success objective.

Correlation analysis has been used in critical success factor studies (Wixom & Watson, 2001; Hwang & Xu, 2007) and was deemed suitable for achieving this research objective. The resulting estimates of the correlation analysis, defined as the correlation coefficients (denoted R) indicate the strength of the association between the dependent and independent variable. The value of [R] can range from -1.00 to +1.00. The value of +1.00 represents a perfect positive correlation, while the value of -1.00 represents a perfect negative correlation. If R= 0, then there is a lack of correlation between the independent variable and the dependent variable (McDaniel & Gates, 2002; Field, 2005). The significance of correlation estimates that yield $\rho <= .05$ is considered borderline statistically significant, while the value of $\rho <= .005$ or $\rho <= .001$ levels are often considered `highly' significant (Saunders et al., 2003; Field, 2005). It must be stated that the level of statistical significance indicates how much confidence one should have in the results obtained rather than the strength of the relationship, which can be influenced by sample size. Furthermore, there is also the issue *of Type-1* and *Type-2* errors to consider. The former means accepting the null hypothesis when in fact it should be rejected based on its statistical significance, and the latter means rejecting the null hypothesis when in fact it should be accepted, based on its statistical significance (Field, 2005; Pallant, 2009). The R-squared is the coefficient of determination denoted as [R^2]. In regression analysis, the coefficient of determination [R^2] can combine several independent variables in the form of multiple regressions to predict the single dependent variable, in which case [R^2] estimates the predictive power of the regression (Cramer, 1998; Hair et al., 1998). However, this depends on the researcher's objective and the actual regression data meeting a number of assumptions (Hair et al., 1998; Field et al., 2005).

4.5.2: Case Study

4.5.2.1: Justifications

Business intelligence implementation is a contemporary and practical phenomenon, and the case study approach was adopted in this study to enable a richer understanding of the process and challenges of BI implementation and how the critical success factors are applied in a real-life setting. Saunders et al., (2003) noted that the case study strategy enables a rich understanding to be gained regarding the context of a phenomenon and how the process is being enacted. Remenyi et al. (1998) highlighted that case study research has two main purposes: firstly, it can be used to create a story or narrative description of the phenomena being studied; and secondly, it can be used to establish the validity and reliability of the evidence. Yin (2003) opined that case studies have substantial ability to generate answers to the questions of 'why', 'what' and 'how', although he noted that the 'what', more quantifiable questions tend to be more of the concern of survey strategy. Bryman and Bell, (2003) noted that the strength of a case study is in its more holistic, context-based approach.

Of course there are also concerns about the case study approach. Robson (2002) highlighted the descriptive nature of writing, which may emphasise a particular viewpoint and conclusion, and can be biased. Yin (2003) noted that case studies have been criticised for taking too long to undertake, which can result in long and unreadable conclusions. There is also a concern about the ability to generalise beyond a single case. However Saunders (2002) argued that case studies are not intended to generalise but to explore phenomenon and gain greater insight into a specific case. In the same vein, Bryman and Bell (2003) argued that the case study is aimed at analytical generalisation rather than statistical generalisation. A major objective of this study is to extract the experiences of organisations that have implemented business intelligence systems, with a particular focus on the critical success factors. Clearly the 'what' and 'why' aspects of the research were addressed by the large survey sample. However, the questionnaire survey was not designed to extract a greater in-depth understanding of the rationale behind the "how" process that lies behind the phenomenon. Thus, a case study was undertaken to gain a greater insight into the process of business intelligence implementation that a standard questionnaire would not be able to provide and thus this complemented the survey. It was also intended to explore potential issues including enabling cross-organisational analysis and a comparison that could enrich the research findings. The overall purpose was to elicit more detailed information from the participants to understand the BI implementation processes.

4.5.2.2: Interview Question Design

The study adopted a semi-structured interview technique (Collins & Hussey 2009). The overall theme of the interview was critical success factors of business intelligence system implementation, although questions were also asked about other key areas as the interview developed. The flexibility offered by this approach allowed for a number of themes to be explored, yet did not restrict the topics covered or the flow of the conversation (Kumar, 2005; Saunders et al., 2003). Opportunities were given to the interviewees to comment on areas that were perhaps not well covered in the questions, but might be relevant to the process of the BI project implementation in their organisation. The interview questions for the research were guided by the following rules (Collins & Hussey 2009),

- Provide a context by firstly briefly explaining the purpose of the interview.
- Ask only questions that are needed for the analysis.
- Keep each question as short and simple as possible
- Avoid the use of jargon, ambiguity and negative questions
- Avoid leading questions and value-laden questions that suggest a 'correct' answer

- Avoid calculations and memory tests
- Avoid questions that could cause embarrassment or offence
- Ensure confidentiality

4.5.2.3: Interview Pilot and Sample Selection

The interview questions were reviewed with the supervisory team and suggested changes were made. The interview process itself was piloted with professional work colleagues to evaluate its appropriateness and timeliness, after which final minor changes were made where necessary to the interview questions.

The interview sampling criteria employed in this study were: (a) organisations that had implemented a BI system in the UK; (b) organisations from two industrial sectors; (c) a mix of public and private sector organisations for comparison (McAdam & Reid, 2000). Another criterion employed was the participant's position in the organisation such as business intelligence manager, project manager, and head of information technology, chief information officer (CIO), senior manager or major stakeholder who had played a key role and was familiar with the process of business intelligence implementation in the organisation.

Wilson (2002) noted that using a sample reduces the focus of the research and increases its reliability and validity. Attewell and Rule (1991) provided some guidance for case study research, noting that "*Clearly it is not necessary to carry out fieldwork across an entire sample of firms, but one should study firms across a spectrum - the centre and extremes; the least and most successful some typical firms*" (p.314). Collin and Hussey (2009) noted that it is important that the right people are asked who have sufficient knowledge and experience and who can address the questions.

In total, individuals from four organisations that met the sample criteria were interviewed (see Table 3.2). Two were taken from the railway industry and the other two were from the commercial sector. The purpose of the inclusion of a major business intelligence independent software vendor (ISV) was to gain the perspective of an independent supplier. The four case studies gave the advantage of richness, comparability, similarity and diversity across the issues to be investigated (Trochim, 2001; Yin, 2003).

Table 4.3: Interviewees Profiles.

Organisation	**Sector**	**Interviewee Role**
UK Office of Rail Regulation	Railway	Business Intelligence Manager
Transport for London (TFL)	Railway	Principle Developer, BI System
Gap Incorporated	Fashion Retailer (Commerce)	Business Intelligence Manager
SAS Incorporated	Independent Software Vendor (ISV)	Business Intelligence Evaluation Manager

Source: Own.

It should be pointed out that although efforts were made by the researcher to interview as many people as possible in each organisation, unfortunately the companies could only allow one participant due to staffs engagements and lack of time. Obviously, with more participants per investigation, more data could be obtained, which could enrich the investigation. This is highlighted in the limitations section. However it must be stated that the participants interviewed in each organisations were key stakeholders given their role in the project. They had experience of the BI system implementation from the beginning to the end (initiation, planning, design, deployment and post implementation management). Furthermore, the interview participants had an average of 16 years' experience in the IT industry, and eight years' experience in BI and the related business applications.

4.5.2.4: Interview administration technique

All of the interviews were face-to-face and took place at the organisation's head office in London, United Kingdom. The interviews took place over a four-month period. Prior to the interviews, the researcher had met three of the four interviewees at separate IT industry conferences on Business Intelligence held in London between October 2012 and June 2013, where the interviewees were key participants and made presentations about their experiences of business intelligence implementation in their organisation. The researcher had asked the interviewees questions at the conferences during their presentations, firstly to gain an understanding of their implementation experiences, and secondly to initiate some form of contact. Subsequently, the interviewees were contacted by telephone to explain the purpose of the research and request an interview and an engagement email was sent to them to arrange a meeting. The engagement letter stated the purpose of the interview, and it assured the anonymity and confidentiality of the interviewee, stressing that it was purely an academic exercise (for sample interview letter, see Appendix 8).

The interview questions were sent in advance of the interviews to aid the recollection of key facts. Collins and Hussey (2009) stressed that interviews are not merely idle conversations, but should aim at gaining in-depth and authentic knowledge about events. They noted that a good way to achieve this is through *critical incident recollection techniques* pertinent to the key facts (Flanagan, 1954). In this research, the interviews were tape-recorded with the consent of the interviewees for recollection purposes (Oppenheim, 1992; Creswell & Clark, 2007). During the interview sessions, the researcher focused on the conversation and maintained eye-contact with the interviewee. In order to validate the responses, paraphrasing of the answers was carried out continually throughout the interviews to allow both the interviewee and the interviewer to check the understanding of the responses and reduce interviewer bias (Jankowicz, 2000; Oppenheim, 1992). The interviewees were asked if they could provide organisational documents or any useful materials related to the progress of their BI implementation that may be of relevance to the research. To encourage the interviewees, it was indicated that a copy of the key research findings would be sent to them, which could be of value in future similar IT implementations. On average, each interview lasted for about one and a half hours. At the end of the interview, a follow-up email was sent to the interviewee to thank them for participating, and to seek their consent if needed for further clarification.

4.5.2.5: Interview Data Management and Analysis Techniques

In this study, the qualitative data management process encompassed a number of steps, including: data capture, input, editing, screening, loading and coding. Bryman and Bell (2007) noted that these steps are essential before data analysis is carried out to ensure confidence in the results. The primary method of data capture was semi-structured, tape-recorded interviews, and immediately after each interview, the tape recording was transcribed and a summary document was created for each interview. Thereafter, all of the interview transcripts were loaded into the computerised qualitative data analysis system as a named project. The qualitative data coding and analysis process was aided by the use of *Qualrus*; a computer-aided qualitative data analysis system available at http://www.qualrus.com.

The study adopted thematic content analysis. This is an inductive approach that involves classifying and organising the data according to themes, concepts and emerging categories, which are then synthesised within appropriate parts of a broader thematic framework (Ritchie & Lewis 2005). Thematic analysis builds on the grounded theory approach, which draws inferences from observations, conversations and objects (Bryman & Bell 2003). Thematic content analysis is commonly used in qualitative analysis and was deemed most suitable for this stage of the research (Krippendorff, 2004).

To facilitate the qualitative data coding and analysis, the study developed *a priori* themes and sub-themes on the research phenomenon "critical success factors of business intelligence", the processes of BI system implementation, and BI success attributes from the theoretical understanding of the subject gained from the literature review. Furthermore, a *posteriori* themes and codes that emerged from inducing the qualitative data were also created during the data analysis and coding process. In total, about one hundred themes, sub-themes and attributes were coded, representing segments of interview texts on the phenomenon of business intelligence implementation. The study also used the *Qualrus* computerised system intelligence function *QTools*. This Qualrus function provides summary lists of codes, frequencies, code pairs, segments where codes appear, views and links between codes, including segment interpretation and aids in qualitative data analysis, relationships and theory building (Brent et al., 2002). From this information, the study was able to identify commonalities and differences in the case studies, and clearer emerging themes of "why" and "how" with regard to certain "actions" in the process of BI implementation. It also enabled the study to confirm or refute some of the earlier findings from the survey study. Appendices 16 -21 provide a list of codes, their description, links with other codes and the segments in which they appeared, created from the *Qualrus* computerised system.

4.6 Research Quality

Bryman and Bell (2007) argued that good research is dependent not only on its purposefulness and relevance, but importantly, also on the reliability and validity of the research instruments.

4.6.1 Reliability

Reliability means the repeatability, consistency and accuracy of the test instrument. Under the same experimental conditions, the test result should be the same, and the less the error variance, the more reliable the test (Hair et al., 1987). Moser and Kalton (2001, p.353) stated that, "*A scale or test is reliable to the extent that repeat measurements made by it under constant conditions will give the same result*". Statistically, reliability is generally classified into two types, namely: external and internal reliability. External reliability compares cumulative test results with each other as a means of verifying the reliability of the measure, while internal reliability refers to the degree to which items in a set of measurements are homogeneous (Samson & Terziovski, 1999). Some procedures for testing reliability include test-retest, split-half reliability and Cronbach's alpha (Bryman & Bell, 2007; Hair, 2006).

Reliability was addressed in this study firstly through the data collection procedure. Costello et al. (2005) and Hair (2005) noted that the sample group must be large enough, relative to the variables for the factor analysis, to be taken as reliable. In this study, the sample consisted of 102 participants, and there were 16 variables. Therefore the sample\variable ratio was 6:1, which is considered large enough for the results to be taken seriously (Hair, 2005; Field, 2007). Finally the study employed Cronbach's alpha [α] to test the internal consistency and inter-item reliability of the solution. Cronbach's alpha measures how closely related the set of items in the solution are as a group. The value ranges from 0 to 1; the nearer the value is to 1, the better the reliability. If the value is low, it is either because there are too few items, which dilute the reliability, or there is not enough commonality among the item variables, to indicate any commonality and reliability. Estimates greater than .70 are generally considered adequate to meet the criteria of internal consistency and reliability (Hair, 1998; Kline, 1999). The survey data reliability results are discussed in Chapter Five.

For the qualitative data, reliability, authenticity and trustworthiness (Lincoln & Guba, 1985), were achieved through tape-recording the interviews, as the tape recordings could be played many times. To increase data analytical reliability, citations from the relevant transcribed tape-recorded portions of the interviews and organisational documents were used where appropriate (Bryman & Bell 2007). The reliability of the qualitative analysis instrument was also improved by the use of the computer-aided qualitative data analysis software, *Qualrus* http://www.ideaworks.com/qualrus.

4.6.2: Validity

Validity refers to the appropriateness of tools and whether the test instruments adequately measure the characteristics that they intend to test or something else. There are different types of validity: internal and external validity, content validity, criterion validity, and construct validity (Bryman & Bell, 2007). The content validity of a questionnaire refers to the representativeness of the item content. This is the manner in which the questionnaire and its items are built to ensure the reasonableness of the object of study (Collis & Hussey, 2009).

The construction of the survey instrument for the study was based on the preliminary literature review from which the research model was derived. This was followed by three stages of pre-testing of the research questionnaire, involving academics and practitioners, before the final research instrument was administered. These processes ensured that the questionnaire measured the content that it was designed to measure, including ensuring that the measurement scales were appropriate. Construct validity for the study was demonstrated by the use of the same measurable scales, i.e., the Likert scale, to assess the participants' perceptions regarding the research questions. This was followed by factor analysis, to access the item construct validity which estimates the 'unifactoria' structure of the item variables

(Hair, 2006; Field, 2005). Statistically, a high correlation among variables is generally considered as indicative of strong construct validity.

Regarding the qualitative data, four interview case studies were undertaken. Collins and Hussey (2009) noted that multiple cases increase the methodological rigor, thereby strengthening the comparability, reliability and stability of the research findings, including the external validity. Tape-recording the interviews increases the validity, authenticity and trustworthiness of the research (Lincoln & Guba 1985) by eliminating errors, omissions and misrepresentations in the participants' responses (Bryman & Bell, 2007; Collins & Hussey, 2009). This process was backed up by organisational documents with permission and the use of the computer aided qualitative data analysis system, QUARUS, which eliminates human error. This study followed tape recording techniques and used organisational documents as in previous studies that are considered reliable and valid.

Finally, this study adopted a mixed methods triangulation approach. Kaplan et al. (1988) noted that triangulation increases the reliability and validity of research. They stressed that mixing methods can alert researchers to potential analytical errors and omissions that is unlikely to occur if only one method is used.

4.6.3 Ethical Consideration

Singer and Vinson (2002) stressed that it is imperative for the researcher to consider ethical issues from the very outset of the research. Jankowicz (2000) noted that the consideration of ethical issues enhances the credibility of research as it improves levels of trust between the researcher and the respondent. Kvale (1996) provided some guidelines for ethical considerations such as informed consent, confidentiality, and the role of the researcher. In conducting this research, ethical issues were considered prior to and during the process, all of which were guided by Kingston University research code of practice (www.kingston.ac.uk), which hinges on general ethical considerations for academic research. This revolves around four main areas, namely: no harm to participants, informed consent, no invasion of privacy and no deception (Bryman & Bell, 2003). What this meant in practice in this research was:

(1) Participants were made to understand that the purpose of the research was academic.

(2) Interview and survey data was only obtained with their consent.

(3) Participants were made to understand that they could withdraw at any point.

(4) Respondents name would not be identified.

(5) Research information would be held securely at Kingston University.

The study also sought to achieve a high level of integrity, by carefully avoiding fabrication, falsification and plagiarism and following standard research citing practices. Israel and Hay (2006) noted that research needs to promote integrity to assist follow-up researchers in building their research on accurate foundations to the benefit of general knowledge.

4.7 Chapter Summary

This chapter provided details of the research methodology and design for the data collection and analysis. It discussed the theoretical and philosophical assumptions underpinning the choice of research design and methods in order to understand the rationale for undertaking certain activities and the use of research techniques. The chapter noted that the research design, methods and philosophical assumption are intractably linked, with the latter fashioning the others. In analysing the philosophical paradigms underpinning the research, three major methodologies were discussed, namely: positivism, constructivism and realism, to create a background understanding.

The chapter next discusses the methodological approach adopted by previous BI studies in an attempt to position and justify this study's approach. The study sought to address the questions of "what", "why" and "how" in understanding the phenomenon of BI implementation, and adopted a realist research paradigm, employing mixed methods research that combines qualitative and quantitative techniques. It was noted that this triangulated approach allows for richness of data and a comprehensive treatment of the elements that constitute the practical process of business intelligence system implementation.

The chapter then discussed details of the data collection and analysis techniques employed at each stage of the empirical research process for both the quantitative survey study and the qualitative interview case study. Finally the chapter discussed issues related to research quality including the reliability and validity of methods. It also discussed issues related to ethical considerations and how these were addressed during the research. This chapter basically sets the foundation for the empirical fieldwork of data collection and analysis, which constitute the content of the next two chapters.

CHAPTER FIVE: QUANTITATIVE DATA ANALYSIS

5.1 Introduction

This chapter presents the results and analysis of the survey data from major stakeholders in organisations that have implemented business intelligence systems. The main objectives are: (a) to explore the relationship between the critical success factors of BI system implementation, (b) to access their degree of criticality relative to others, (c) to establish the extent to which the critical success factors impact business intelligence implementation success, and (d) to examine which critical success factor relates to which BI success measure.

The chapter is made up of two major parts. The first section profiles the survey respondents and their organisations, including background information on BI implementation in these organisations. Descriptive statistics such as mean, standard deviations, frequencies, percentages and Chi-square were used to analyse the background profile information.

The second section begins with the results of a reliability assessment of the research instruments in preparation for further statistical analysis. Factor analysis is then used to explore the interrelationship between the critical factor variables and their impact on BI implementation success, while bivariate correlation analysis is used to examine the pair-wise relationship between each critical factor and each BI success attribute in order to establish which set of critical factors is most likely to influence the realisation of specific BI success objectives. The statistical analysis was aided by the use of statistical computing software (SPSS version 21).

5.2: Profile of Survey Respondents.

The survey questionnaire was distributed to about 780 organisations in the UK. 102 questionnaires were returned, representing a response rate of about 13%, which is considered acceptable in management research (Jankowicz, 2000) and is consistent with similar studies in information systems research (Moffett et al., 2003).

5.2.1 Respondents Position and Experience with BI systems

The majority of the respondents were senior executives and chief information officers (CIOs). As Figure 5.1 shows, CEOs and CIOs accounted for 34.3% of the survey respondents, while middle-level managers such as business intelligence managers and project managers accounted for about 23.6% of the respondents. A further 24.5% were IT professionals, architects or consultants, while another 9.9% were business intelligence users or analysts, and finally about 7.8% represented other groups. The result indicates a fair split between middle-level managers and IT professionals\consultants, the two groups most likely to have played a key role in and be knowledgeable about their organisation's BI system implementation.

Figure 5.1: Respondent position

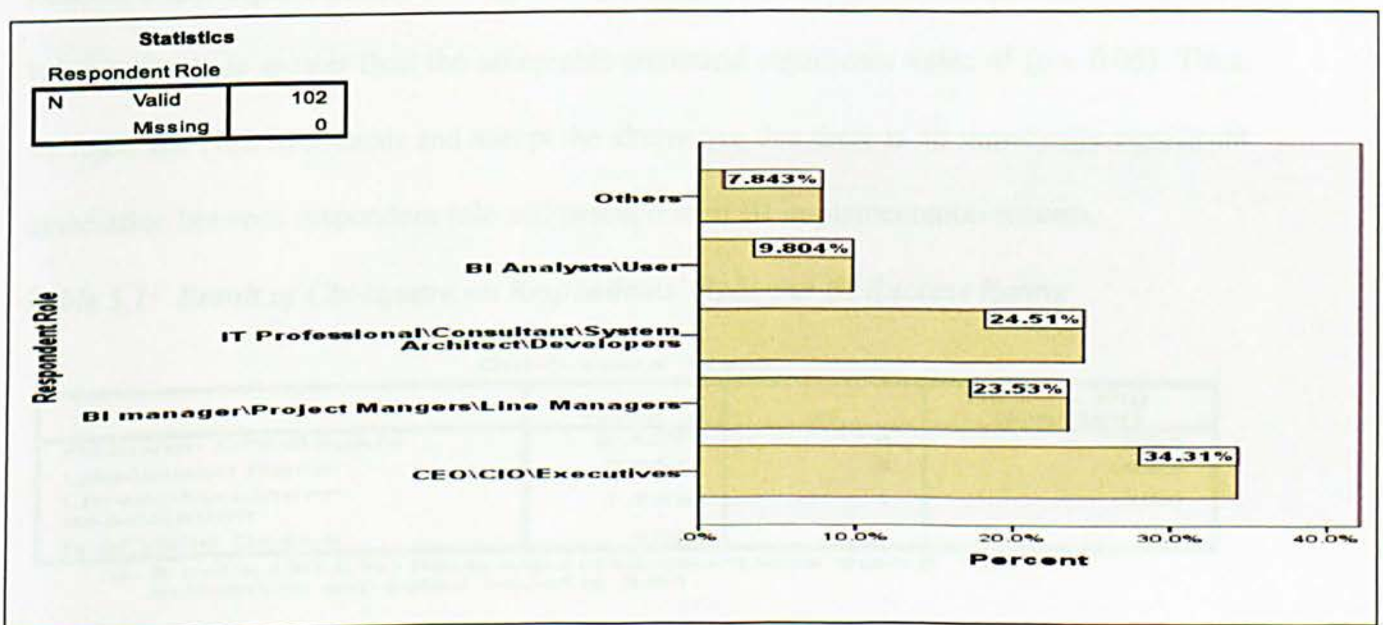
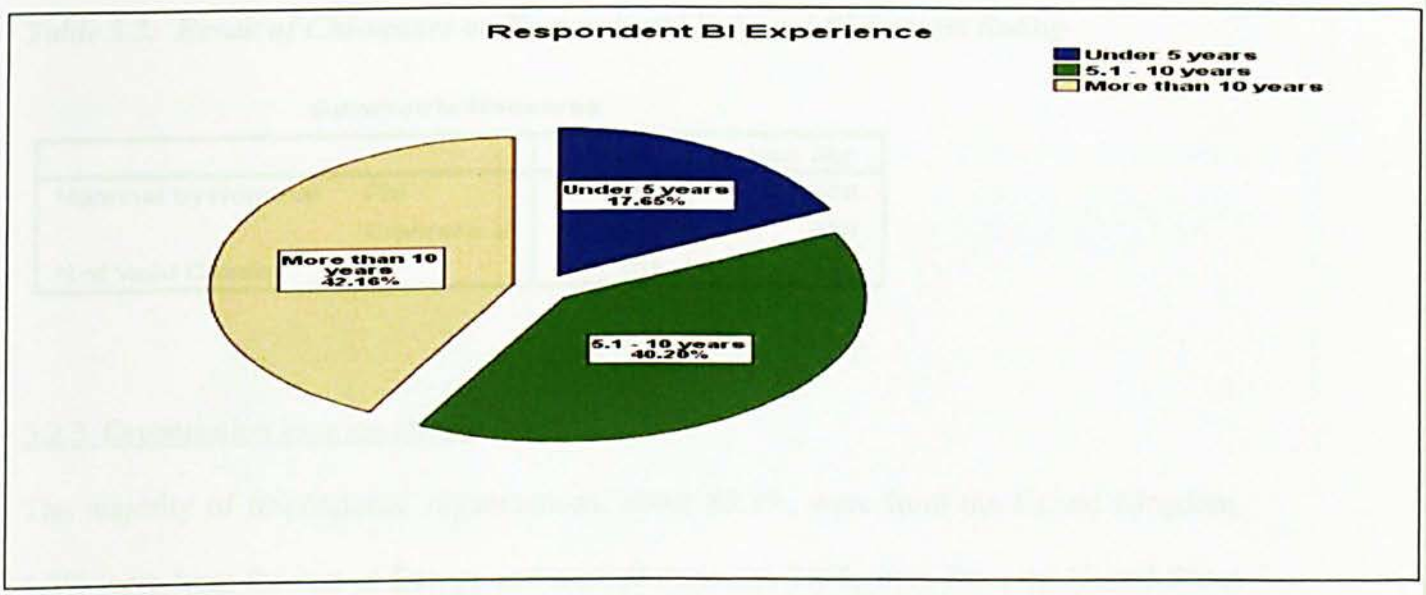


Figure 5.2 below shows the respondents' years of experience with BI systems. The majority, about 82%, had more than five years' experience of business intelligence systems, which is a good level of experience from which to gain valuable opinions about the phenomena in question.

Figure 5.2: Experience with BI



Using Chi-Square, the study further sought to test whether any association exists between the respondents' roles and the reported BI implementation success. Table 5.1 below shows the Pearson's Chi-Square estimate of ($\chi2=2.427$) at (p = 0.658) level of significance. The p-value estimate is greater than the acceptable statistical significant value of (p = 0.05). Thus, we reject the Null hypothesis and accept the alternative that there is no statistically significant association between respondent role and perception of BI implementation success.

Table 5.1: Result of Chi-square on Respondents' Role and BI Success Rating

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.427[a]	4	.658
Likelihood Ratio	2.457	4	.652
Linear-by-Linear Association	1.729	1	.189
N of Valid Cases	102		

a. 3 cells (30.0%) have expected count less than 5. The minimum expected count is 3.61.

Table 5.2 further shows Phi and Cramer's V symmetric measures of the strength of association between respondent role and BI success rating. As is evident from the table, the strength of association between the two variables is weak at .154 and .154 respectively, at (p=.674) significant value, further strengthening the earlier Chi-Square test result of insignificant association between respondent role and BI implementation success.

Table 5.2: Result of Chi-square on Respondents' Role and BI Success Rating

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.154	.658
	Cramer's V	.154	.658
N of Valid Cases		102	

5.2.3. Organisation location and Revenue

The majority of respondents' organisations, about 85.3%, were from the United Kingdom, 6.7% were from the rest of Europe and a small minority, 2.0%, were from the United States and Canada. A further 3.9% were from Asia and 2.0% were from the Middle East and Africa. Although all of the survey questionnaires were sent to UK addresses, the small variations in the respondents' locations might be due to organisations with UK operations but with overseas headquarters.

Figure 5.3 Organisations' Locations

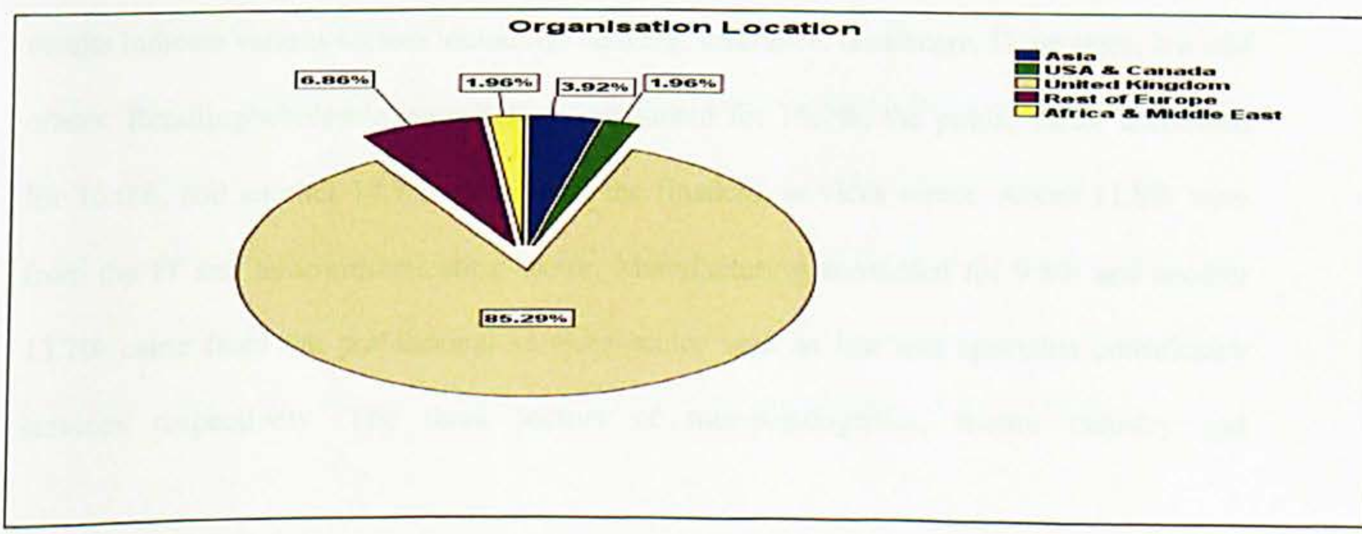
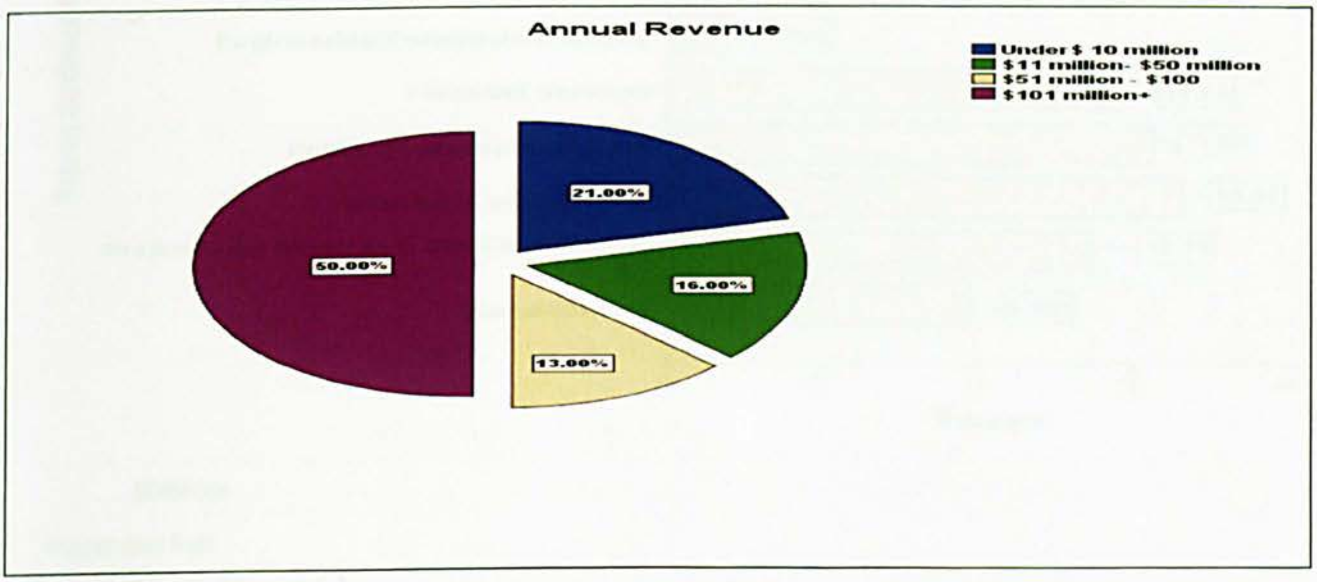


Figure 5.4 shows the participants' organisations' revenues. The largest group, 50.0%, of the organisations had annual revenue in excess of $100 million dollars. A further 13% had revenues ranging from $51 to $100 million US dollars. About 19.2% had revenues of between $11 million and $50 million US dollars, and another 21% had revenues of under $10 million. Generally, half of the respondents' organisations could be considered large in terms of revenue in excess of $50 million US dollars.

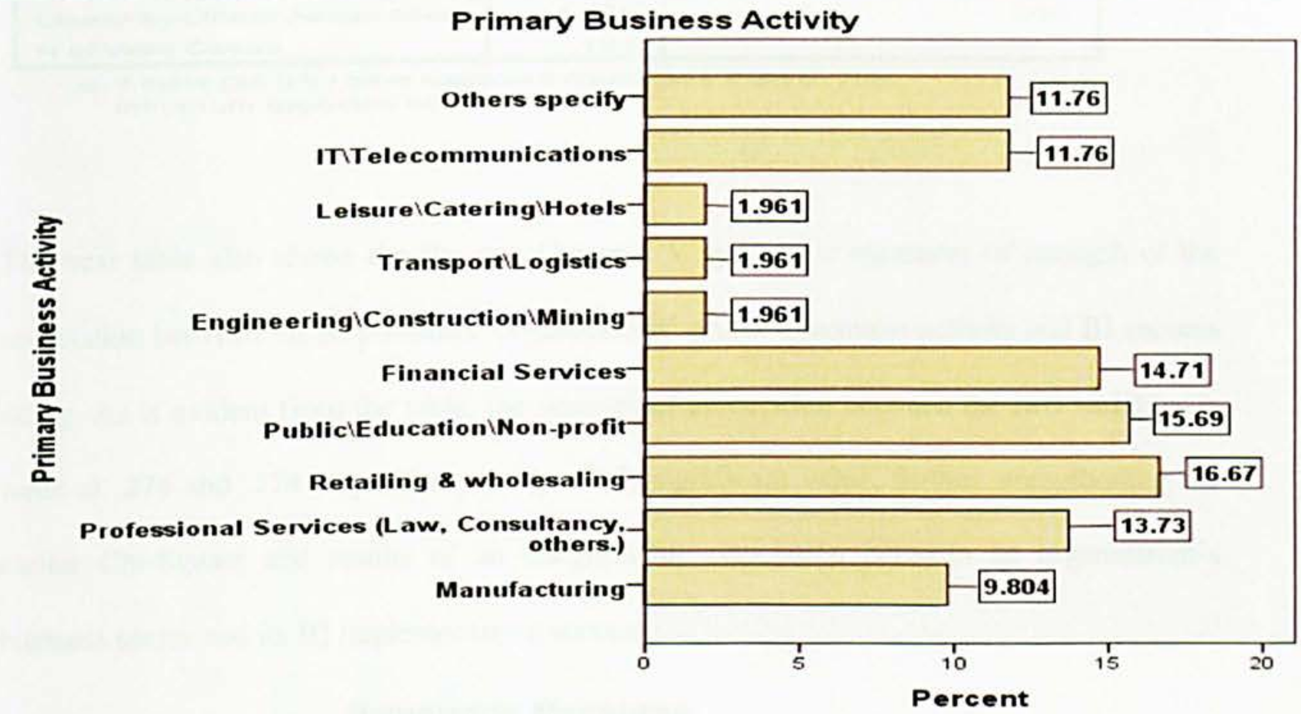
Figure 5.4 Organisations' Revenues



5.2.4 Organisations' Primary Business Activities

Figure 5.5 shows a breakdown of the organisations' primary business activities. The survey results indicate various sectors including: banking, insurance, healthcare, IT services, law and others. Retailing/wholesale organisations accounted for 16.7%, the public sector accounted for 16.0%, and another 14.7% came from the financial services sector. About 11.8% were from the IT and telecommunication sector. Manufacturing accounted for 9.8% and another 13.7% came from the professional services sector such as law and specialist consultancy services respectively. The three sectors of transport/logistics, leisure industry and engineering/construction accounted for about 2% respectively, with a final 11.7% being accounted for by others.

Figure 5.5: Organisations' Business Activities



Statistics

Respondent Role

N	Valid	102
	Missing	0

Using Chi-Square, the study further sought to test whether any association exists between an organisation's business activity and its reported BI implementation success. Table 5.3 below shows a Pearson's Chi-Square estimate of ($\chi2$=7.678) at *p-value* of (0.567) significance. The *p*-value estimate is greater than the acceptable statistical significance value of ($p = 0.05$), and thus we reject the null hypothesis and conclude that that there is no statistically significant association between BI implementation success and an organisation's business activity.

Table 5.3: Result of Chi-square on Organisation's Industry Sector and BI Success Rating

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.678[a]	9	.567
Likelihood Ratio	8.584	9	.476
Linear-by-Linear Association	4.728	1	.030
N of Valid Cases	102		

a. 7 cells (35.0%) have expected count less than 5. The minimum expected count is .90.

The next table also shows the Phi and Cramer's V symmetric measures of strength of the association between the respondents' organisations' primary business activity and BI success rating. As is evident from the table, the strength of association between the two variables is weak at .274 and .274 respectively, at (p=.567) significant value, further strengthening the earlier Chi-Square test results of an insignificant association between an organisation's business sector and its BI implementation success.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.274	.567
	Cramer's V	.274	.567
N of Valid Cases		102	

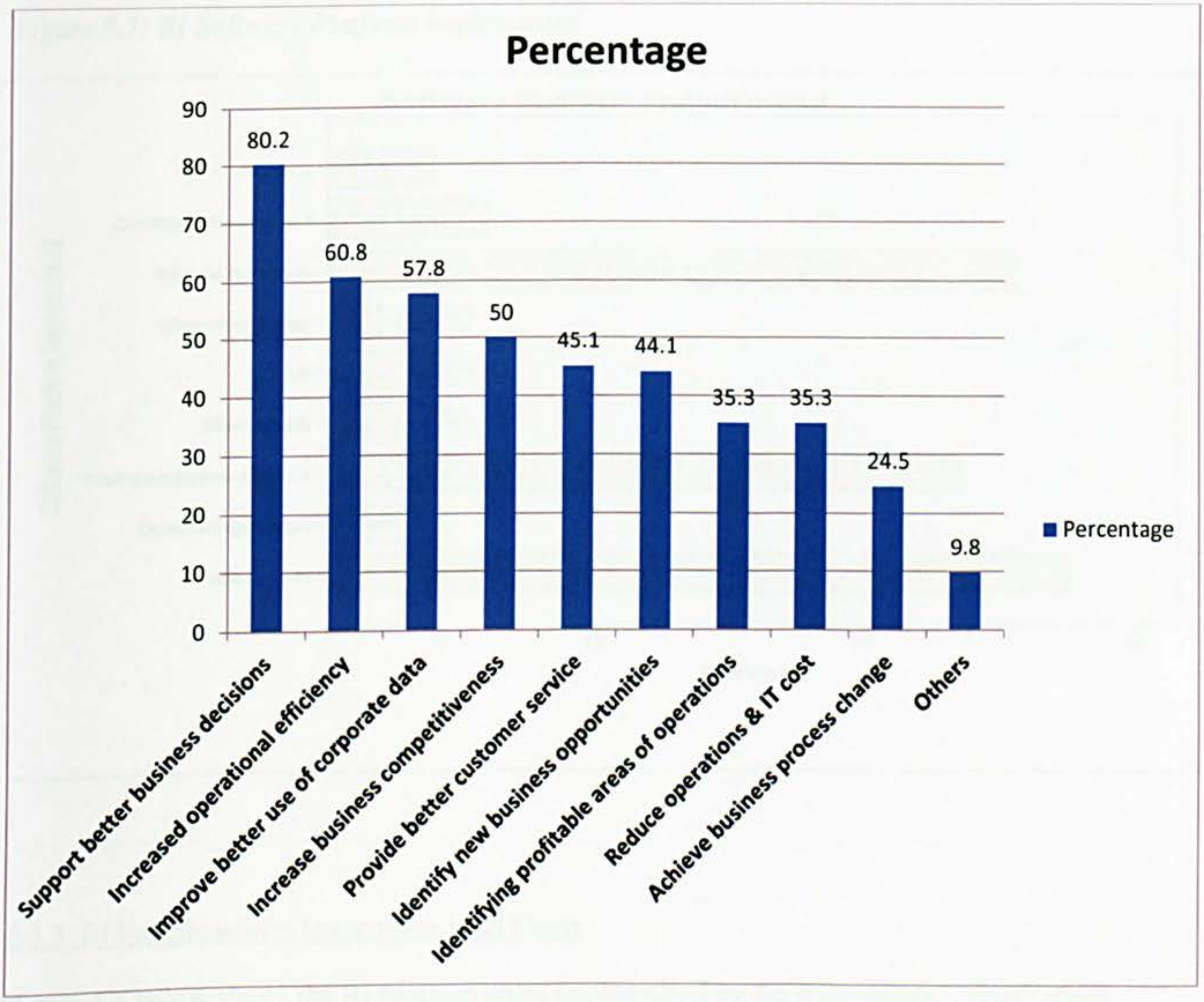
5.3: Understanding BI implementation in Organisation

5.3.1: Reasons for Implementing BI systems

Figure 5.6 indicates the reasons why the respondents' organisations had implemented a business intelligence system in ascending order of importance. The respondents were asked to tick all that applied. A total of 80.2% of the respondents indicated [*Support for better business decision*] as one of the reasons for implementing a BI system. Another 60.8% indicated [*increased operational efficiency*] and another 57.8% indicated [*improved better use of corporate data*]. A further 50% indicated [*increase business competiveness*], 45%

indicated [*provide better customer service*], and 44% indicated [*Identify new business opportunity*] respectively. A further 35% of the respondents indicated [*reduce operation and IT cost*], and another 35% indicated [*identify profitable areas of investment*]. About 24.5% indicated [*Achieve business process change*], and 9.8% indicated [*other*] reasons. Interestingly, more than 50% of the respondents indicated [*support for better decisions*], [*increased operational efficiency*], and [*better use of corporate data*] as three outstanding reasons for implementing BI.

Figure 5.6: Reasons for implementing BI

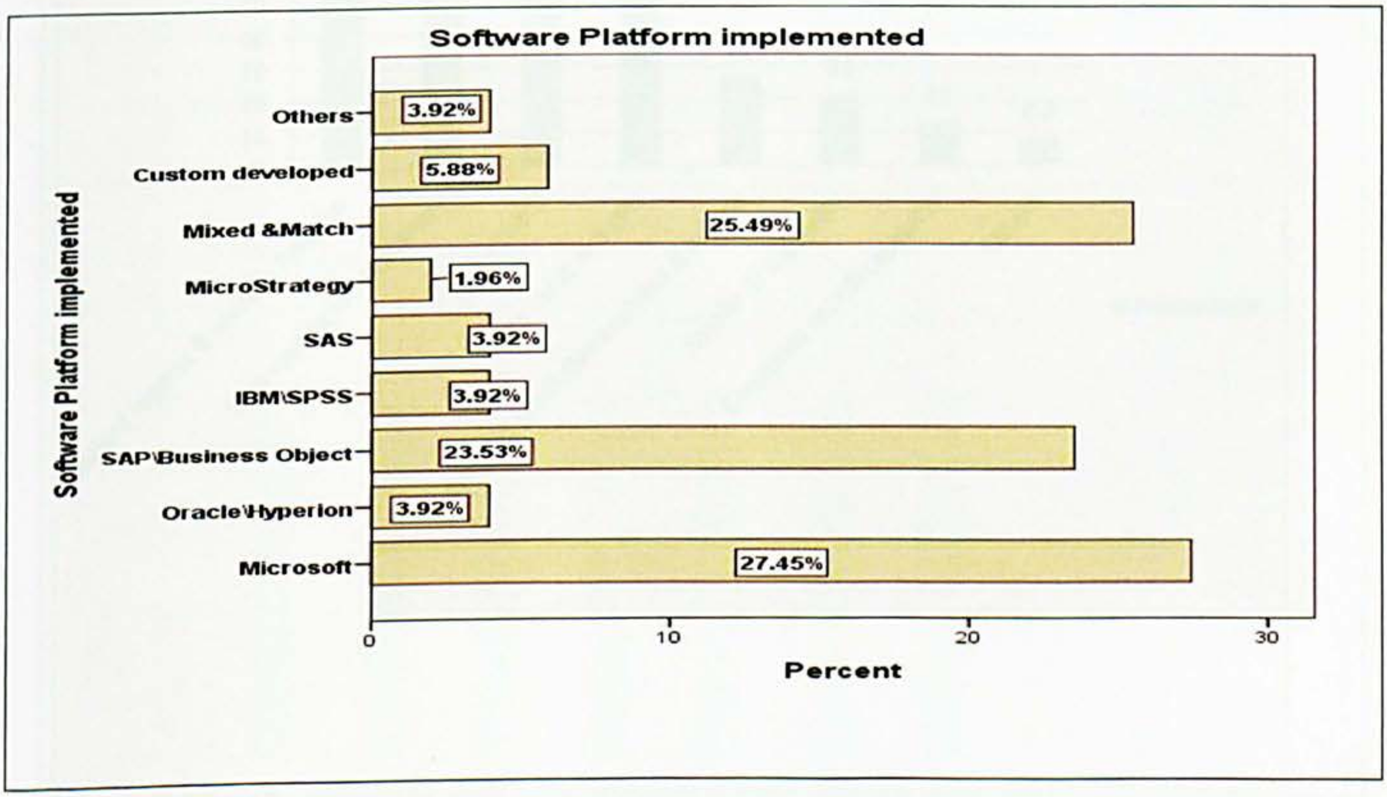


***** Respondents were asked to tick all that apply***

5.3.2: Software Platform Implemented

The majority, 27.5%, of respondents' organisations had implemented the [*Microsoft BI platform]*, 25.5% had deployed a [*mix of software*] and a further 23.5% had implemented the [*SAP BI suite*]. A further 4% had implemented [*SAS*], [*Oracle Hyperion platform*] and *[IBM SPSS*] respectively, and another 2% had implemented [*MicroStrategy*] BI platform. Finally, about 6% had implemented [*Custom developed*] and another 4% had implemented [*other*] BI platforms. Incidentally, Microsoft and SAP, the two biggest software companies worldwide, were the most popular BI software platforms implemented by the participating organisations.

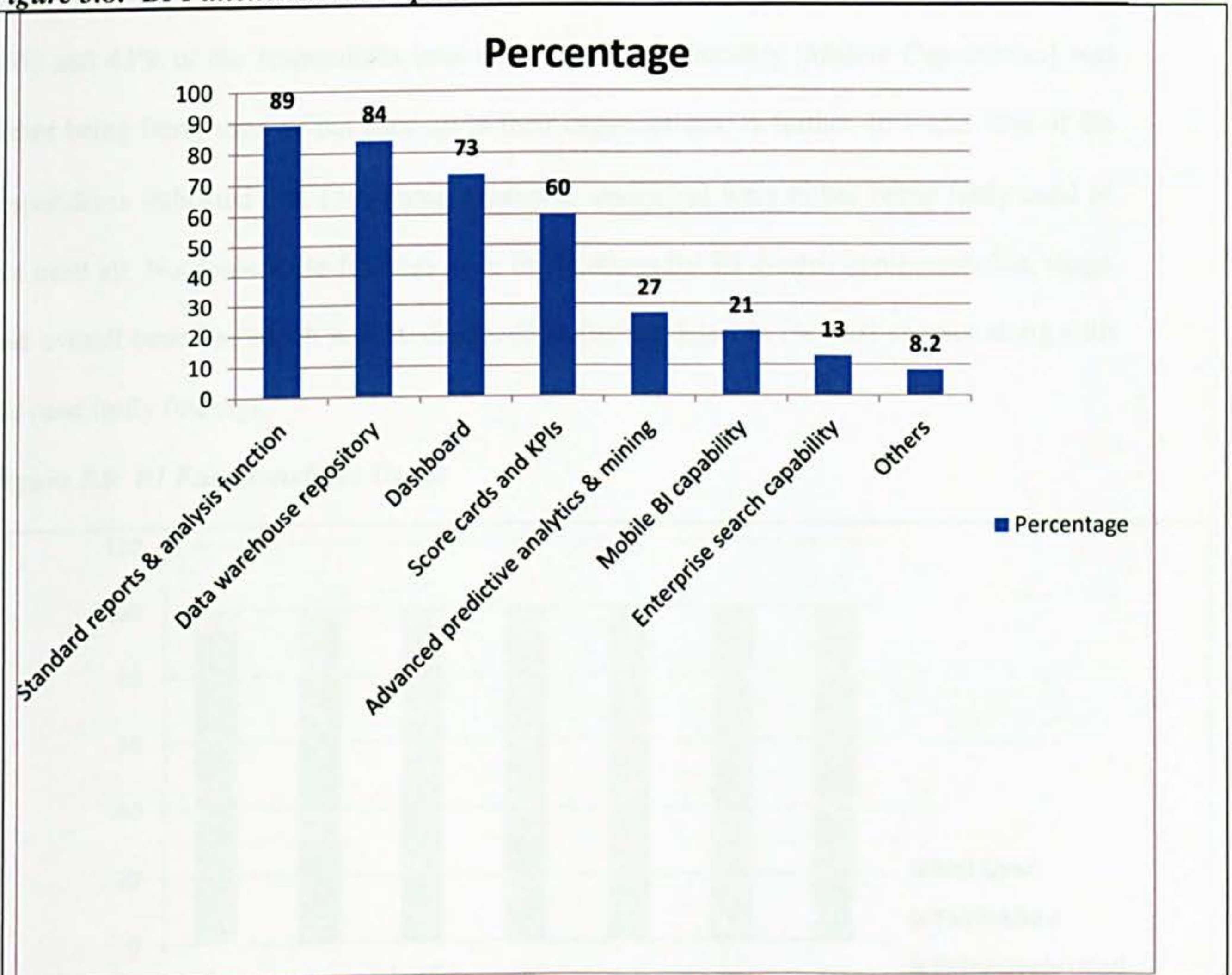
Figure 5.7: BI Software Platform implemented



5.3.3: BI Functionalities Implemented and Usage

Figure 5.8 below shows the BI functionalities implemented by the respondents' organisations in ascending order. The majority of the organisations, 89%, had implemented BI [*standard reports and analysis function*], another 84% had implemented BI [*centralised data* *warehouse\repository*], and a further 73% had implemented [*dashboards*]. About 60% had implemented [*Scorecards and key performance indicators KPIs*]. Less than 27% of the participating organisations had implemented [*advanced predictive and analytics*] capabilities and about 21%, had implemented [*mobile BI capability*]. Only 13% had implemented [*enterprise fuzzy search*] capabilities and 8% indicated others.

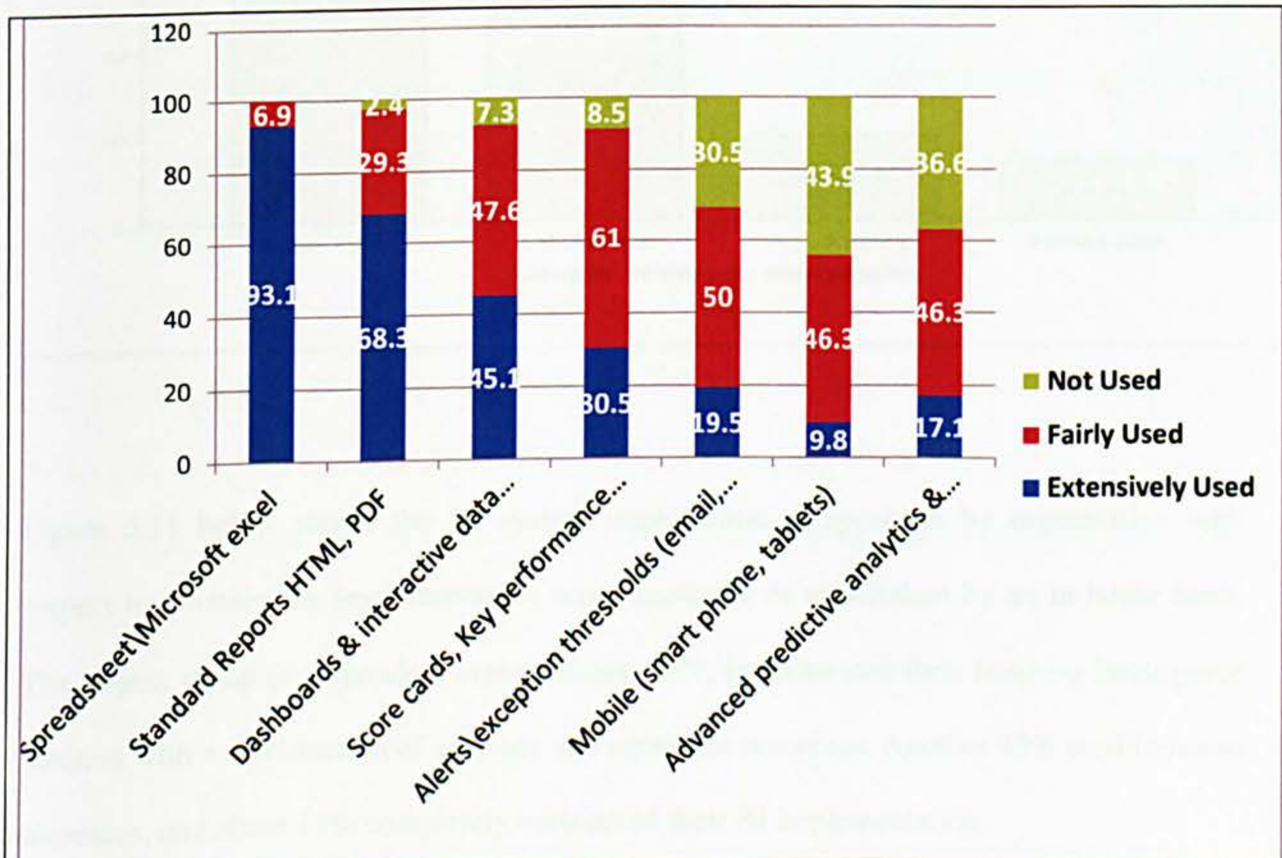
Figure 5.8: BI Functionalities Implementation



* Respondents were asked to ticked all that applied

The results of the BI functionalities implemented were not a surprise. However, when the respondents were asked to indicate the extent of usage of the implemented BI functionalities as either [*extensively used*], [*fairly used*] or [*not used*], the results were rather interesting. As shown in Figure 5.9 below, while 93% of the respondents indicated extensive use of [*Spread sheet/Microsoft excel*], another 68% indicated extensive usage of [*Standard Reports*] and 45% indicated extensive use of [*Dashboards*]. The extensive usage of BI functionalities such as [*Mobile Capabilities*] and [*Advanced predictive analytics & simulations*] scored very low, at 10% and 17% respectively. Incidentally those BI functionalities that scored low on extensive usage, scored rather higher on either fairly used, or not used at all. For instance, 46% and 43% of the respondents indicated that BI functionality [*Mobile Capabilities*] was either being fairly used or not used all in their organisations. A further 46% and 36% of the respondents indicated that [*Advanced predictive analytics*] were either being fairly used or not used all. No doubt these findings have implications for BI system implementation, usage and overall benefits, which will be discussed in further detail in the next chapter along with the case study findings.

Figure 5.9: BI Functionalities Usage



5.3.4: Duration and Approach to BI Implementation

The duration of BI project implementation varied from one year to more than five years. The majority of the organisations, 53%, completed their implementation within about one to three years. Another 30% completed their implementation in less than a year. A further 10% took between three to five years, and 7% completed their BI implementation in over five years. Figure 5.10 below shows the results for the duration of BI implementation.

Figure 5.10: Duration of Implementation

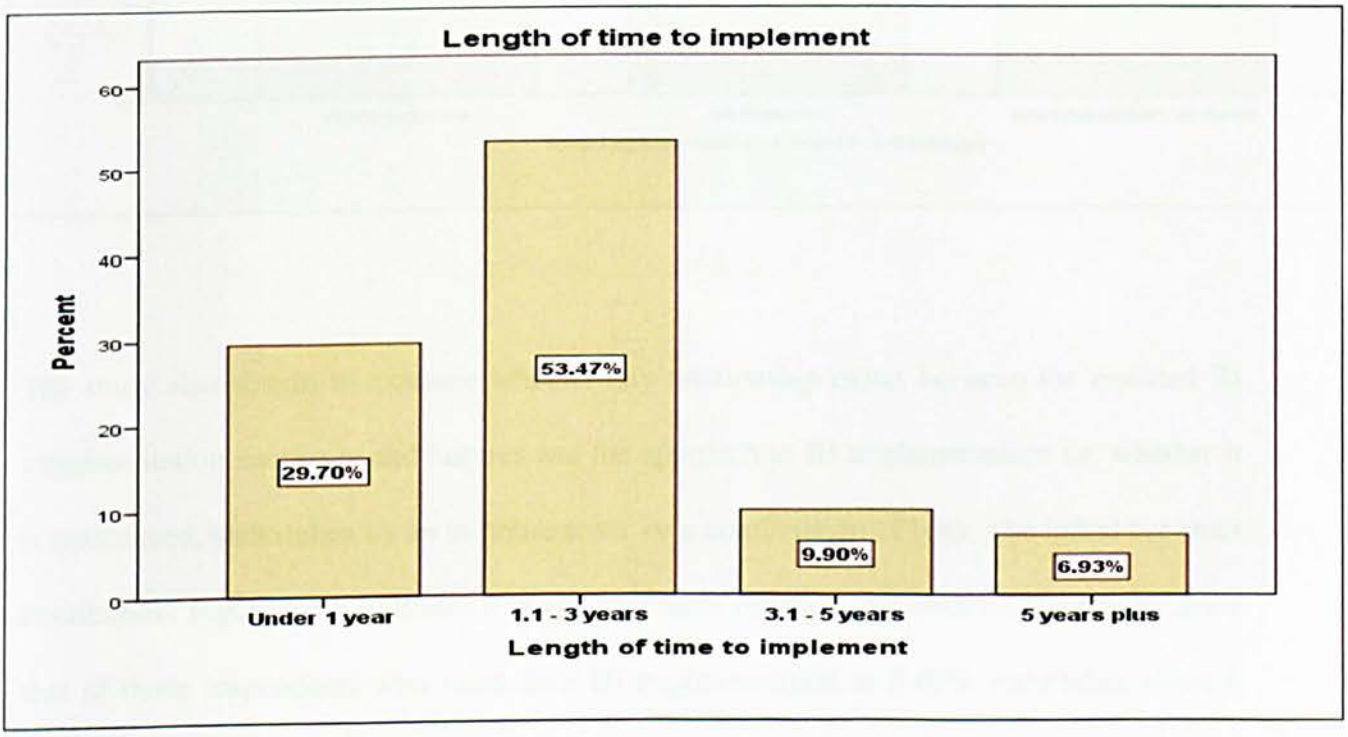
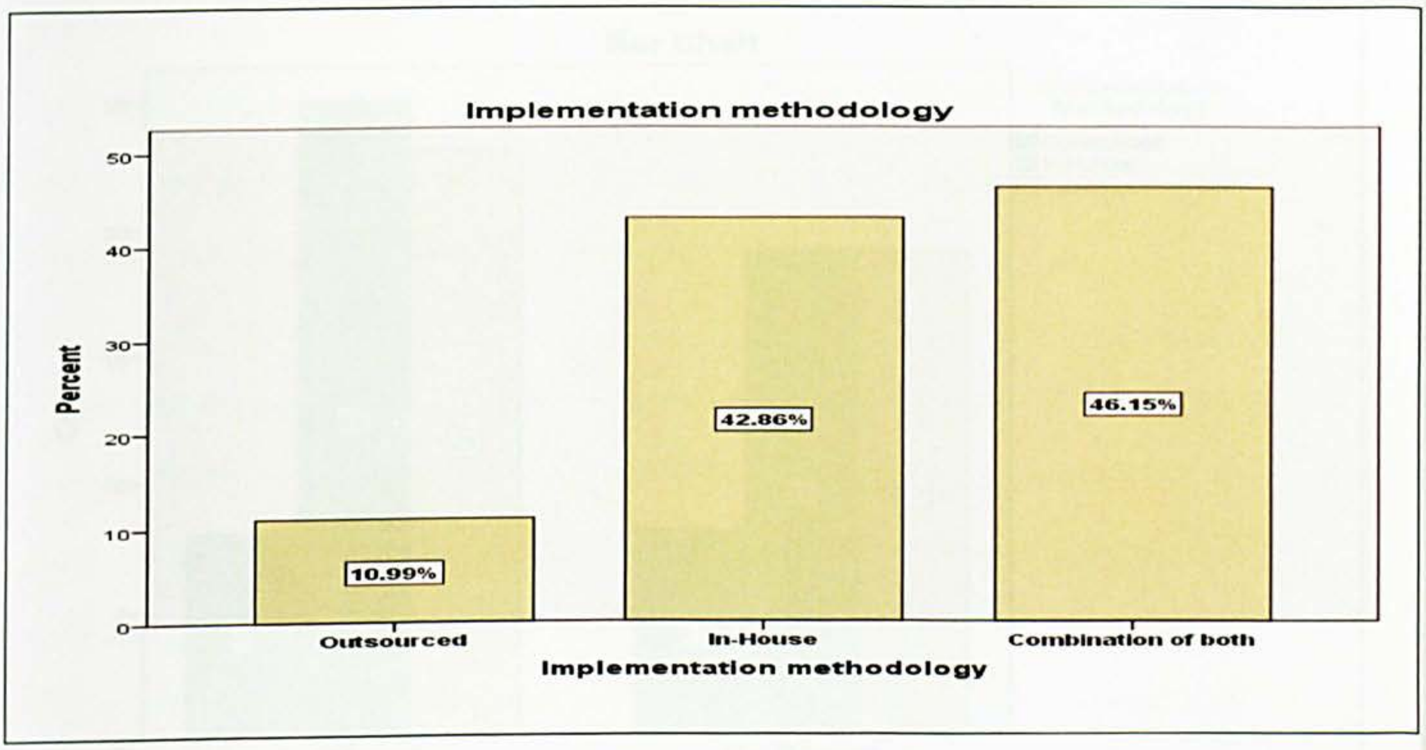


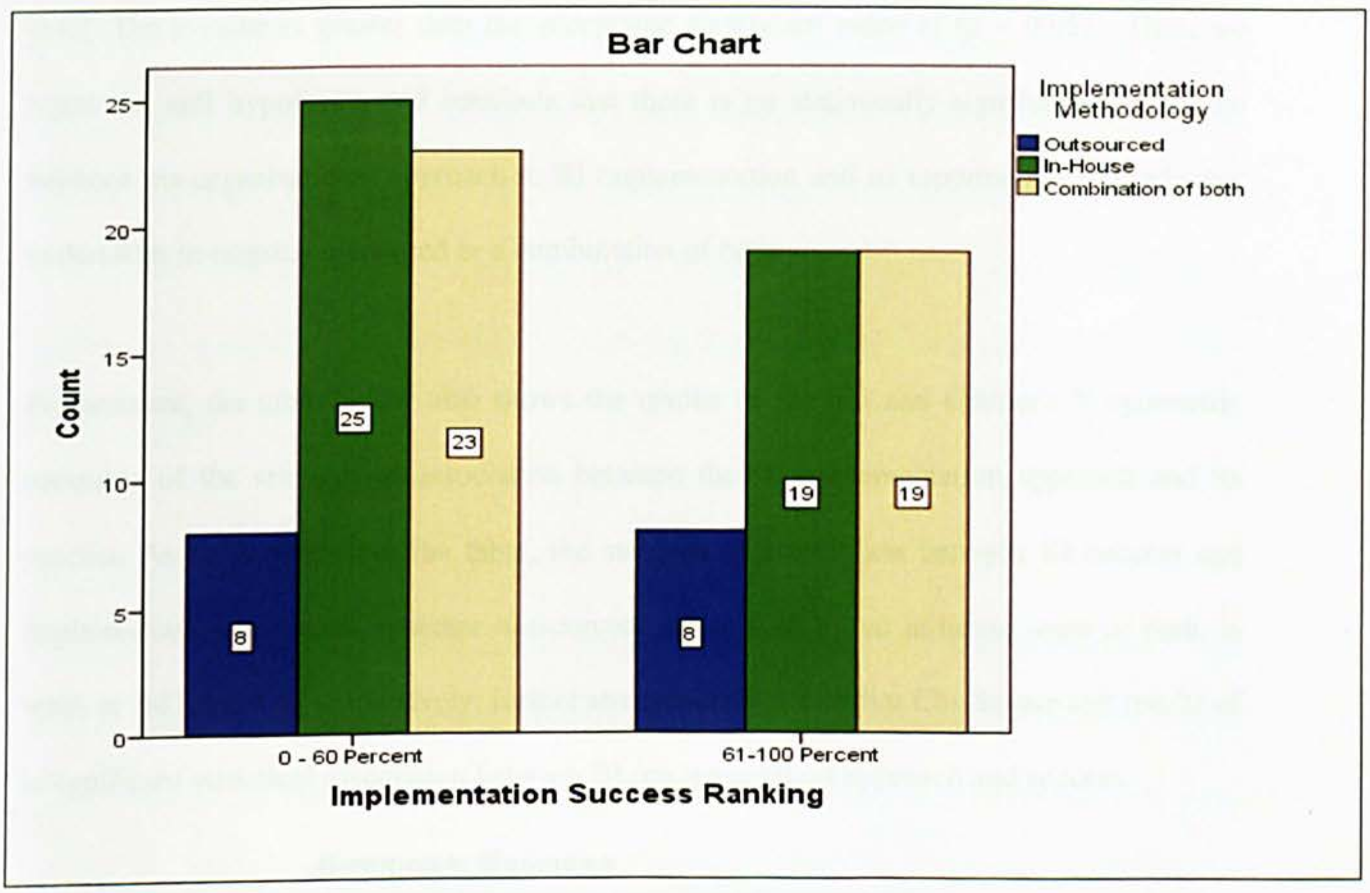
Figure 5.11 below shows the BI system implementation approach by organisation with respect to whether the implementation was outsourced or undertaken by an in-house team. The largest group of respondent organisations, 46%, implemented their business intelligence solution with a combination of in-house and outsource resources. Another 43% used in-house resources, and about 11% completely outsourced their BI implementation.

Figure 5.11: BI Implementation Approach.



The study also sought to examine whether any relationship exists between the reported BI implementation successes and failures and the approach to BI implementation i.e. whether it is outsourced, undertaken by an in-house team, or a combination of both. The initial bar chart distribution, Figure 5.12, indicates a slight noticeable pattern. For instance, the results show that of those respondents who rated their BI implementation at 0-60% successful, about 8 *[outsourced],* 25 used an [*in-house team*], and 23 used a [*combination of both*]. Also, of those who reported their implementation as being between 61-100% successful, about 4 [outsourced], 19 used an [in-house team], and 19 used a [combination of both], see results table below.

Figure 5.12: BI Implementation Approach Measured with Success Rating



However, when a Chi-Square test of association was used to examine whether any pattern exists between BI implementation success or failure and the approach to implementation i.e. if undertaken by an in-house team, outsourced or a combination of both, the test results indicated that the association is not statistically significant. Table 5.4 below shows the results of the Chi-Square test of association.

Table 5.4: Results of Chi-Square on Implementation Approach and BI Success

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.221[a]	2	.895
Likelihood Ratio	.220	2	.896
Linear-by-Linear Association	.041	1	.840
N of Valid Cases	102		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.22.

The results indicate a Pearson's Chi-Square estimate of ($\chi2$=.221) at (p = .895) significance level. The p-value is greater than the acceptable significant value of (p = 0.05). Thus, we reject the null hypothesis and conclude that there is no statistically significant association between the organisations' approach to BI implementation and its reported success, whether undertaken in-house, outsourced or a combination of both.

Furthermore, the table below also shows the results of the Phi and Cramer's V symmetric measures of the strength of association between the BI implementation approach and its success. As is evident from the table, the strength of association between BI success and implementation approach, whether outsourced, undertaken by an in-house team or both, is weak at .047 and .047 respectively, further strengthening the earlier Chi-Square test results of insignificant statistical association between BI implementation approach and success.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.047	.895
	Cramer's V	.047	.895
N of Valid Cases		102	

The purpose of this initial profile and Chi-square analysis undertaken at this preliminary stage was to examine whether any statistically significant association exists between the reported business intelligence implementation success or failure and some of the organisational characteristics such as industry sector or approach to BI implementation, which would need to be taken into consideration in further statistical analysis and interpretation.

5.4: Assessment of Reliability and Validity

In section 4.6 of the research design chapter, the study discussed research quality and the need to assess reliability and validity of the research instruments and results. This section presents the results regarding the item reliability and validity. Hair et al. (1987) stressed that prior to any rigorous statistical data analysis, it is proper for the research instrument to be assessed for reliability and validity, to ensure that problematic items are excluded from further analysis.

5.4.1: Reliability Analysis

Reliability measures the extent to which the test instrument and variables produce the same results under the same empirical conditions (Bryman & Bell, 2006). Sekaran (2003) indicated that this means the repeatability, consistency and accuracy of the test instrument, and is the "goodness" of the measure. Nunnally and Bernstein (1994) recommended assessing the coefficient alpha as the first measure of reliability of multiple variables. Cronbach's coefficient alpha measures internal consistency and how well items correlate with the entire scale. An acceptable level for Cronbach's alpha is 0.7 (Nunnally, 1978; Hair et al., 2002). Field (2005) noted that Cronbach's alpha is the most common method for testing reliability in business and social sciences research. Another measure of research variable reliability is the corrected item-total correlation, which subtracts each item's score from the correlated total score to eliminate false-whole correlation. Variables with negative corrected item-total correlation are then eliminated from further statistical consideration. The generally accepted threshold for corrected item-total correlation is 0.3 and above (Nunnally & Bernstein, 1994).

Table 5.5 below provides the results of both of the reliability assessments undertaken in this study. As indicated, all of the item variables have very good Cronbach alpha scores of above

0.7, which is above the recommended of level. The item-total correlation values for all of the variables were also greater than 0.3. Both results indicate very satisfactory outcomes (Nunnally & Bernstein, 1994) and thus, it can be concluded that the variables have adequate reliability for the next stage of the statistical analysis.

Table 5.5: Results of Cronbach's Alpha

CSF Variables	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Business case & vision	.463	.853
Management support	.354	.857
Executive sponsorship	.408	.855
Adequate Budget	.439	.853
Nature of organization	.329	.860
Communication with stakeholders	.481	.852
Project management	.568	.848
Change management	.462	.852
Software selection & support	.535	.849
Technical infrastructure	.487	.851
Data management	.396	.855
Implementation methodology	.628	.843
Team skills	.584	.847
User participation	.647	.843
User training	.551	.848
User intuition	.494	.851

5.4.2: Validity Analysis

Validity assesses the appropriateness of the tools and whether the test instruments sufficiently measure the characteristic that they intend to test. Bailey (1991) argued that validity measures the credibility of the research instrument and should be one of the most important considerations. Construct validity is important especially when dealing with unobservable social constructs such as "success" and "happiness" (Nunnally, 1978). Hair et al. (1987) noted that relationships among these unobservable constructs can be tested indirectly via observed variables, often referred to as "latent variables" (Field, 2005). A standard measure of construct validity of quantitative data is factor analysis (Hair et al., 1987). This explores the underlying common dimensions among research instruments and checks for 'unifactoriality' or that no multi-collinearity exists among the research variables, which is indicative of strong construct validity (Hair et al., 2006; Costello & Osborne, 2005).

5.5: Factor Analysis.

<u>5.5.1: The use of factor analysis in this study.</u>

Nunnally (1978) noted that factor analysis has many uses: "*Firstly, factor analysis reduces a large number of variables into a smaller set of variables (also referred to as factors). Secondly, it establishes underlying dimensions between measured variables and latent constructs, thereby allowing the formation and refinement of theory. Thirdly, it provides construct validity evidence of self-reporting scales*" (cited in Williams, 2012, p.2). Byrant et al. (1999) noted that factor analysis is the method of choice for interpreting self-reporting questionnaires.

Factor analysis is used in this study to:

(1) Explore, validate and interpret the relationships between the critical success factors.

(2) Evaluate the construct validity of the research instrument.

(3) Examine the relative importance of the item scales; the critical success factor variables.

(4) Evaluate the extent to which the critical success factors impact on BI implementation success.

(5) Refine the initial research conceptual framework.

Factor analysis is a multivariate statistical technique that examines the underlying common structural dimension and interrelationships among research instruments. It has the superior advantage of not only being able to reduce large datasets, but also handling the problem of multi-collinearity, which is common in standard multiple regression techniques and which can make interpretation and conclusions arising from such techniques unsatisfactory and questionable (Hair et al., 2006). It should be stated that factor analysis is not without controversy (Williams et al., 2010; Beavers et al., 2013), not least due to its complexity. Field (2005) indicated that factor analysis involves a series of iterations and sequential steps that include: (a) determining data factorability; (b) factor extraction; (c) faction rotation; (d) factor loading; and (e) factor naming and interpretation. Hair et al. (2003) and Beavers (2013) suggested using multiple criteria at each step of the iteration process.

5.5.2: Determining Factorability

To determine the data factorability in this study, four criteria were used: (a) sample size, (b) correlation matrix, (c) Bartlett's test of sphericity; and (d) the measure of sampling adequacy (MSA) (Field, 2005; Hair et al., 2003; Costello, 2008).

Schertzer and Kernan (1985) recommended using data that come from interval scales that measure the respondents' preferences on different levels such as Likert scale scores. It should be pointed out that there are debates in the literature regarding whether Likert scales generate interval or ordinal data (Carifio & Perla, 2008; Murray, 2013). With regard to sample sizes, there are generally two recommendations; one emphasises an absolute minimum number of cases (N), while the other emphasises the cases-to-variable ratio (N: X). Gorsuch (1983) and Kline (1979, p.40) recommend at least 100 cases. Hatcher (1994) and Hair et al. (2003) stated that the data for factor analysis should not normally consist of less than 100 samples or it should have an appropriate sample\variable ratio of 5:1. Correlation matrix criteria define the level of correlation between variables, and identify variables that correlate fairly well with other variables, ($R > .30$), but are not perfectly correlated ($R < 1.0$) (Fields, 2009). Bartlett's measure of sphericity tests the null hypothesis at ($p < .05$) that the original correlation matrix is an identity matrix. In other words, it assesses whether sufficient correlations exist among the research variables to warrant factor analysis (Hair et al., 2003). Finally, the measure of sampling adequacy, MSA, estimates the overall correlations and patterns between the variables. Stewart (1981) noted that Bartlett's test of sphericity and the Kaiser-Myer-Oklin

(KMO) measure of sampling adequacy (MSA) are two of the best measures for determining the suitability of datasets for subsequent factor analysis.

In this study, the data used were obtained from a five-point Likert scale survey of 102 samples with 16 variables, with a sample\variable ratio of 6:1, thus satisfying both numeric data criteria (Hair et al., 2003). The correlation matrix table (see Appendix 18) also shows an acceptable number of correlations between the variables with (R >.30) but (R <.9), thus satisfying the correlation matrix criteria. Furthermore, Field (2000) observed that if the significance of the correlation determinant is greater than 0.00001, then there is no multi-collinearity (p.445). In this study, the significance of the correlation determinant is .011, thereby satisfying the determinant criteria. Table 5.4 shows the results of the KMO measure of sampling adequacy (MSA) and Bartlett's test of *sphericity*. The KMO measure of sampling adequacy (MSA) was (.827), well above the recommended KMO value of (.60). Hutcheson and Sofroniou (1999) stated that a KMO value of between 0.5 and 0.7 is mediocre, whilst a value of between 0.7 and 0.8 is good, values of between 0.8 and 0.9 are great, and values above 0.9 are superb (Hair et al., 2003). The result of Bartlett's test of sphericity had a significant value of (p =.000), less than (p = 0.05), thus rejecting the NULL hypothesis that the variables are an identical matrix.

Thus the preliminary results based on these multiple measures indicate that the data satisfy the criteria for factor analysis and can be used.

Table 5.6: Result of KMO MSA and Bartlett's Test of Sphericity

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.827
Bartlett's Test of Sphericity	Approx. Chi-Square	430.555
	df	91
	Sig.	.000

5.5.3: Factor Extraction.

The study employed multiple criteria to determine how many factors to extract and retain. Hair et al. (2002) recommended: (a) using components with *eigenvalues* greater than 1.0; (b) retaining items with a communality of above .40; and (c) ensuring that enough factors meet the percentage of variance explained above 50%. Field (2005) also recommended examining the scree plot[6] for the point of inflexion. Eigenvalues express the relative importance of a variable in an analysis. The study chose principal component analysis (PCA) given that data reduction and the interrelationship between the research variables are two major objectives.

The initial unsatisfactory factor analysis solution was made up four factor clusters that had a total variance explained of 56 %, with most variances explained in the first factor. The CSF variable items *Adequate Budget* and *Nature of Organisation* had a communality of below .40, at .356 and .322 respectively (see Appendixes 12 and 13), which is considered unsatisfactory (Field 2005), and therefore these were dropped from the subsequent factor rotation. It should be reiterated at this juncture that factor analysis measures the total inter-item correlation with other items, not item total scales on their own. So for instance, while the variable Nature of Organisation has a mean score of 3.72 on a five-point Likert scale (see Appendix 9), and would definitely be considered important, factor analysis measures the sum of its correlation with other variables, which, in this case, is below the acceptable range. Further analysis and interpretation is undertaken with regard to this result in the light of other findings in the study's discussion in Chapter Seven.

[6] Scree plot: identifies a significant break point from other components to retain for further analysis, generally referred to as the point of inflexion (Field, 2005).

5.5.4: Factor Rotation and Loading.

Williams (2012) noted that factor "*rotation maximises high item loading and minimises low item loading therefore producing a more interpretable and simplified solution*" (p.9). Field (2005) noted that factor rotation maintains items' balance and comparability, given a large number of variables. To proceed with factor rotation, the study employed orthogonal equimax rotation, adopting four criteria: (a) eliminating variables with unacceptable communality (a comfortable range is assumed to be between .40 and .70) (b) eliminating variables with non-significant loading, defined as below .40, to maintain very strong item loading, (c) eliminating variables with cross-loading, and (d) ensuring that every factor has at least two items loaded (Field, 2005; Hair, 2009; Costello, 2008). The essence of these measures is to obtain an improved matrix solution that identifies sufficient and meaningful relationships among the research variables to warrant grouping.

The results of the final factor analysis solution are shown in Tables 5.7 to 5.9 below. First, Table 5.7 indicates that all of the variables have *communalities* above .50 except for one variable (user training), and the *eigenvalues* for all of the items is greater than the acceptable level of 1.0 (Hair 2003), indicative of sufficient inter-item correlation.

Table 5.7: Result of Communalities

Communalities

	Initial	Extraction
Business case & vision	1.000	.504
Management support	1.000	.649
Executive sponsorship	1.000	.584
Communication with stakeholders	1.000	.628
Project management	1.000	.574
Change management	1.000	.609
Software selection & support	1.000	.628
Technical infrastructure	1.000	.647
Data management	1.000	.565
Implementation methodology	1.000	.686
Team skills	1.000	.650
User participation	1.000	.571
User training	1.000	.488
User intuition	1.000	.778

Extraction Method: Principal Component Analysis.

Second, Table 5.8 below, show the result of the total variance explained for the rotated factor analysis solution which is 61%, well above the recommended 50% (Field, 2005). This measures the overall goodness of fit of the model, and is analogous to the coefficient of determination of Pearson's correlation. Hair et al. (2009) noted that in the natural sciences that measure observables, the total variance explained of a factor analysis solution can be as high as 75% or above, while in the arts and social sciences, a value of above 50% is acceptable.

Table 5.8: Result of Total Variance Explained

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.864	34.740	34.740	4.864	34.740	34.740	2.514	17.960	17.960
2	1.348	9.630	44.370	1.348	9.630	44.370	2.315	16.534	34.495
3	1.299	9.278	53.648	1.299	9.278	53.648	2.083	14.875	49.370
4	1.050	7.502	61.150	1.050	7.502	61.150	1.649	11.780	61.150
5	.901	6.434	67.584						
6	.819	5.847	73.431						
7	.699	4.992	78.423						
8	.572	4.086	82.510						
9	.558	3.984	86.494						
10	.462	3.300	89.794						
11	.456	3.254	93.049						
12	.350	2.497	95.545						
13	.326	2.331	97.876						
14	.297	2.124	100.000						

Extraction Method: Principal Component Analysis.

Third, Table 5.9 below shows the results of the final solution component matrix. It is made up of 14 out of the 16 variable items, as two items were dropped. All of the variable items have a factor loading of above .50, which is considered to be a satisfactory item loading (Field, 2005; Hair, 2009; Costello, 2008), and there are four factor clusters. Each cluster has more than three variables loaded except for one that has two items loaded. Hair (2000) noted that traditionally, at least two or three variables must load on a factor so that it can be given a meaningful interpretation. The item results are either 'unifactorial' or no multi-collinearity exists among the research variables, which is indicative of strong construct validity (Field, 2005; Costello & Osborne, 2005).

Finally, in terms of the relative importance of the item scales, the critical factor of technical infrastructure had the highest item loading of .749, in the first cluster, Communication had an item loading of .779 in the second cluster, executive sponsorship had an item loading of .761 in the third cluster, and user intuition had an item loading of .836, in the fourth factor cluster. These represent the most dominant critical success factors within their respective factor clusters. Rummel (1988) noted that each factor represents a scale based on the empirical relationships among others.

Table 5.9: Result of Final Component Matrix

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Technical infrastructure	.749			
Software selection & support	.723			
Implementation methodology	.698			
Data management	.583			
Communication with stakeholders		.779		
Change management		.723		
Project management		.659		
User participation		.500		
Management support			.761	
Executive sponsorship			.742	
Team skills			.595	
Business case & vision			.528	
User intuition				.836
User training				.554

Extraction Method: Principal Component Analysis.
Rotation Method: Equamax with Kaiser Normalization.
a. Rotation converged in 8 iterations.

5.5.5: Factor Naming and Interpretation.

Finally, the four factor clusters were then grouped and named accordingly, as below. Henson and Roberts (2006) noted that the labelling of factors is a subjective, theoretical and inductive process, and "the meaningfulness of latent factors is ultimately dependent on researcher definition" (p.396). Thus, the naming and interpretation of the four factor constructs was accomplished by relating them to the theoretical concepts of business intelligence system implementation. The critical success factor clusters were grouped and named accordingly as:

(1) **Technical Related Factors.** These are tactical-related critical success factors consisting of adequate technical infrastructure, software selection, implementation methodology, and data management and integration.

(2) **Process Related Factors.** These are operational-related critical success factors consisting of project management, change management, communication and user participation.

(3) **Organisational Related Factors**. These are the strategic-related critical success factors consisting of a clear business case and vision, management support, executive sponsorship and team skills.

(4) **User Related factors**. These consist of the user-related critical success factors of user training and user intuition, (a new variable item), included in the research framework for validation

5.6: Bivariate Correlation Analysis.

Having established the interrelationship and the relative degree of importance between the CSF variables, this section sought to address the question of which critical factor variable relates to which BI success measure or attribute adopted for this study.

Given that different organisations may have different preferences with respect to their BI success objective in the implementation process, the aim here was to identity which sets of critical factors are most likely to have a greater influence on the realisation of a particular BI system success objective. Table 5.10 below shows a Pearson's correlation matrix between each of the 14 critical success factors (CSF) and each of the 8 BI success attributes adopted in this study. The respondents were also asked to rank their preference for each BI success attribute on a five-point Likert scale. It is important to mention that there is a decades-old debate regarding whether to treat Likert scale data as interval or ordinal data and whether to use parametric or non-parametric tests (Carifio & Peela 2008; Jamieson 2004). Norman (2010) noted that a Likert scale can be used with parametric tests such as Pearson's correlation without fear of *"coming to the wrong conclusion"* (p.44). This study applied a parametric test following similar studies on critical success factors undertaken by Chow and Cao (2008). The results of Spearman's bivariate correlation are also included in Appendix 15. Table 5.10 below presents the correlation matrix between the CSF and BI Success Measures.

Table 5.10: Correlation Matrix between CSF and BI Success Measures

Critical Success Factors	Mean	Standard Deviation	Easy to use, adaptable and flexible	Quality informatio n	Speedy informatio n retrieval	Support for Mobile BI devices	Data visualizatio n\scorecard s\dashboar d\KPIs	Integration with other systems	Real time data analysis	Advanced predictive analytics
Business case & vision	4.6078	0.61591	.393**	.354**	.178	-.096	.152	.197	.056	.050
Management support	4.2673	0.77319	.412**	.245*	.293**	.144	.175	.210*	.074	.064
Executive sponsorship	4.1569	0.82947	.336**	.310**	.422**	.099	.214*	.151	-.078	.037
Communication with stakeholders	4.1176	0.95745	.267**	.317**	.190	.108	-.043	.070	.037	-.179
Project management	4.1275	0.74024	.343**	.390**	.263**	.015	.154	.183	.075	.084
Change management	3.9804	0.78325	.216*	.428**	.369**	.184	.317**	.281**	.034	.062
Software selection & support	3.7549	0.94854	.273**	.388**	.276**	.031	.271**	.222*	.060	.055
Technical infrastructure	3.7157	0.88304	.151	.324**	.244*	.099	.284**	.225*	.044	.313**
Data management	4.2745	0.82242	.116	.300**	.157	-.036	.064	.123	.017	.064
Implementation methodology	3.6275	0.94315	.235*	.370**	.178	-.036	.265**	.169	.182	.328**
Team skills	4.1471	0.74988	.291**	.183	.240*	.042	.171	.186	.111	.168
User participation	4.1863	0.81727	.184	.278**	.148	-.001	.075	.182	.054	.030
User training	3.951	0.76271	.228*	.214*	.213*	.194	.316**	.385**	.148	.230*
User intuition	3.6667	0.89369	.171	.249*	.191	-.002	.232*	.084	.230*	.176
Pearson Correlation										
**. Correlation is significant at the 0.05 level (2-tailed).*										
***. Correlation is significant at the 0.01 level (2-tailed).*										
N = 102										

Source Own

The significant correlations are marked with an asterisk, with the highest critical factor on BI success attribute highlighted in bold. The results show about 20 pairs of Pearson's correlation coefficients at (p = 0.05) significance levels from the 106 pairwise correlation matrices. The means and standard deviations are in the first two columns. The results indicate for example, that, when it came to the BI objective of [*advanced predictive analysis*], the critical factor of implementation methodology was most correlated at (R = .328). Another critical factor that correlates statistically with this BI objective is technical infrastructure at (R = .313). This indicates an interesting connection that could be harnessed to achieve this particular BI success objective. In the same vein, when it came to the realisation of the BI success objective of [*speed of information retrieval*], the critical success factor of executive sponsorship was most correlated at (R = .412), another critical factor aligned to this BI objective was change management at (R=.369). This suggests a greater influence of these two CSFs in the realisation of this particular success objective, when compared to others.

The implication of the above findings is that since different organisations may place different emphasis on specific BI success attributes in their project, the correlation matrixes provides an indication of the direction and strength of the relationships between each BI success attribute and each critical factor or set of critical factors that suggests areas where organisations should focus more attention in order to realise their BI success objectives.

5.7: Chapter Summary

This chapter presented the results of 102 survey respondents in organisations that had implemented business intelligence systems. The chapter started by presenting the demography of the respondents including some background information on the BI system implementation in their organisation. It also examined whether any statistically significant association exists between the reported BI implementation success or failure and some of the characteristics of the participating organisations such as industry sector, or the approach to BI implementation, which needed to be taken into consideration in further statistical analysis.

The study then assessed the reliability of the research instruments in preparation for the next stage of the factor analysis. Factor analysis was used to explore, interpret and examine the strength of the interrelationship between the critical success factor variables. It was also used to assess the construct validity of the research instrument and the overall impact of the critical success factors on business intelligence implementation success. The results indicate a covariance of four factor clusters dimensions that account for a total variance explained of about 61% of BI implementation success. Bivariate correlation analysis was then used to examine which critical factors are correlated with which success measures and are most likely to influence the realisation of a specific BI implementation objective.

This chapter has presented a comprehensive statistical analysis of the survey data to enrich the understanding of key elements of business intelligence implementation from a large-scale survey. However, further discussion and interpretation of the survey findings in the context of other empirical studies is presented in Chapter Seven. The next chapter presents the results of the detailed case studies with four individual organisations to gain a greater insight into the process of BI implementation in real-life settings.

CHAPTER SIX: QUALITATIVE DATA ANALYSIS

6.1 Introduction

This chapter presents the results and analysis of the interview case study data collected from four organisations that have implemented business intelligence systems. In line with the research objective, the chapter seeks to understand: (a) why these organisations implemented business intelligence systems, (b) what the process involves and the major challenges in implementing a BI project, and (c) how the critical success factors are actually applied in a real-life setting.

In presenting the findings, the chapter discusses the rationale for, and the processes involved in undertaking specific actions. It then compares the differences and similarities in the experiences of the participating organisations. However, no attempt is made at this stage to discuss the findings in relation to the literature and the overall research objective. This is undertaken along with the survey data in an in-depth discussion in Chapter Seven.

6.2: Case Study Analysis

6.2.1 UK Office of Rail Regulation (ORR)

6.2.1.1: Interviewee

The interview was conducted with the Business Intelligence Manager at the organisation's office in London. The interview lasted for about an hour and half.

6.2.1.2: Organisation Background

The Office of Rail Regulation (ORR) is the UK government independent economic and regulatory agency for Britain's railways. It is responsible for monitoring a range of railway operations including: health and safety on the railways, compliance and enforcement. It also undertakes economic regulatory activities such as dealing with anti-competitive and unfair trading practices, providing licences, fare enforcement agreements and where necessary, imposing monetary penalties on railway operating companies, including disseminating official statistics, and supporting passengers and the public. Its activities are backed up by various pieces of legislation such as the Railways Act 1993 and the Railways Act 2005.

6.2.1.3: BI Challenge at ORR

The Office of Rail Regulation (ORR) provides a series of online and offline shared information services reports on network rail activities. These include passenger rail performance and punctuality reports, significant lateness and cancellation reports, freight train performance reports and asset management reports, including reports on railway development works in progress and how they are likely to affect rail passenger trains at destinations. Other reports include health and safety statistics, reports of station closures, general approvals and consents, prohibition notices, licences, and other miscellaneous reports that provide economic and financial advice that underpins all of the ORR's work.

However, much of the data used by the ORR comes from the 35 different railway operating companies that include: (1) mainline network railway companies such as Virgin Trains, Cross-country, London and South East (LSE), First Capital Connect (FCC); (2) underground railways such as London Underground Limited (LUL); (3) light rail and tramways such as the Docklands Light Railway in London, the Tyne and Wear Metro, Manchester Metro link, Nottingham Express Transit, Midland Metro, and the Croydon Trams; and (4) heritage and minor railways, some of which operate in isolation but provide genuine transport facilities and community links (http://www.rail-reg.gov.uk/).

A major challenge is that much of the information from these different railway companies comes in different formats. These data need to be standardised, aggregated and analysed in order to present new information and knowledge to the public, managers and decision makers in the railway regulatory body. According to the Business Intelligence Manager at ORR, the organisation has always had huge data management challenges. He noted that *"before now much of data management process was manual, time consuming and offered limited business insight"*. He also noted that, *"there were no common data quality standards and processes, and no data sharing protocols in place"*.

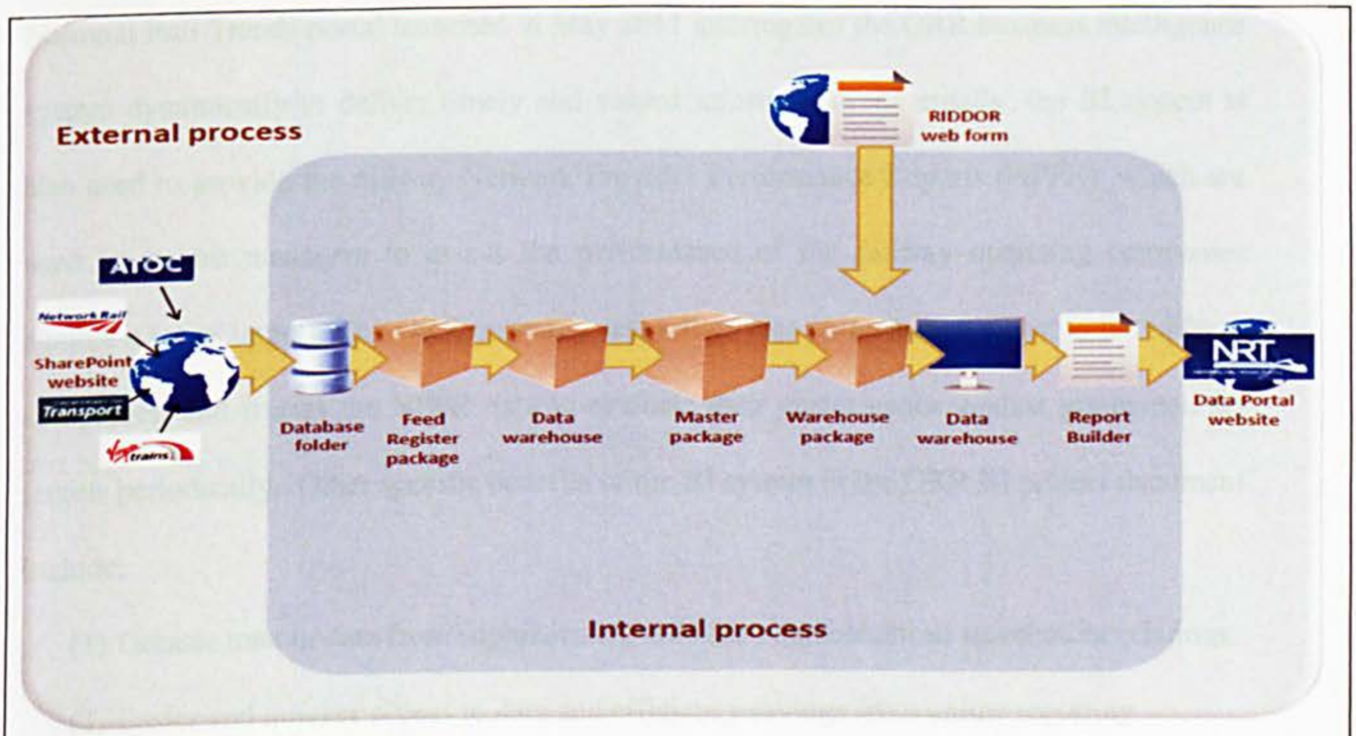
6.2.1.4: BI Implementation at ORR

Subsequently, in January 2009, the ORR engaged an independent management consultant named Mott MacDonald to review its activities around people, processes, data usage and management, which led to the implementation of a business intelligence solution. The consultant recommended:

- Restructuring the information and analysis function
- Introducing data quality standards and processes
- Developing a central data warehouse

These recommendations were presented to the stakeholders, along with a business case and a cost-benefit analysis for a business intelligence initiative. Following approval from ORR's executive, in April 2009 the organisation created a new data information and analysis team responsible for data standards, outputs and analysis functions. At the same time there was an engagement and a memorandum of understanding (MOU) with the various independent railway "data providing organisations" (DPOs) regarding the format, content and timeliness of the provision of data and contact points. Following on from these, two practical initiatives were undertaken, an initial scoping study regarding a centralised data repository, and then the process of developing and implementing the business intelligence system. To undertake the project, ORR outsourced the implementation to a specialist IT Consultant Company called IMGroup, to design, develop and implement the business intelligence system. The technical solution was anchored on the Microsoft SQL Server business intelligence platform that incorporates BI functionalities such as: *Microsoft SQL Server Integration Services*, for data extraction, transformation and loading; *Microsoft SQL Server Analysis Services,* for data modelling, mining and analysis; and *Microsoft SQL Server Reporting Services*, for data reporting and visualisation. The solution included a centralised data warehouse of about 500GB. It also included the use of open source[7]code software called Drupal and Microsoft ASP.net codes. Both of these assisted with pulling the data from the data warehouse onto pre-calculated business logic and developing the BI reports. The figure below illustrated the ORR BI technical architecture.

Figure 6.1: Technical architecture of ORR Business Intelligence Solution:



Source: Internal document, courtesy of ORR.

[7]Open source software refers to freely distributed programming languages developed and maintained by an internet user community (Pearce and Joshua 2012).

6.2.1.5: BI Benefits at ORR

One of the key benefits of the solution according to the Business Intelligence Manager was that for the first time, *"more than 95% of data that came from the various railway data providing organisations DPOs were integrated and stored in one system.* Here individual data uniqueness and formats were harmonised, standardised and transformed into a useable format and business intelligence knowledge. Before now, they had more than one system for storing different DPOs' data, with different analysts reporting from these disparate datasets.

The new ORR business intelligence system displayed business decision reports, canned reports, and official statistics with a new report wizard for custom periodic data to be made publically accessible online (see Figure 6.2). According to the ORR Business Intelligence Manager, *"data dissemination used to be static spreadsheets, cut and paste on web portals, undertaken by disparate teams and websites were hard to navigate"*. The newly enhanced National Rail Trends portal launched in May 2011 interrogates the ORR business intelligence system dynamically to deliver timely and valued information. Internally, the BI system is also used to provide the railway Network Provider Performance Reports (NPPR), which are used by centre managers to assess the performance of the railway operating companies against a set of targets. The ORR normally sets a five-year performance target to the railway companies, and it uses the NPPR data to evaluate their performance against pre-agreed set targets periodically. Other specific benefits of the BI system in the ORR BI project document include:

(1) Greater trust in data from sophisticated validation and enhanced stakeholder relations.

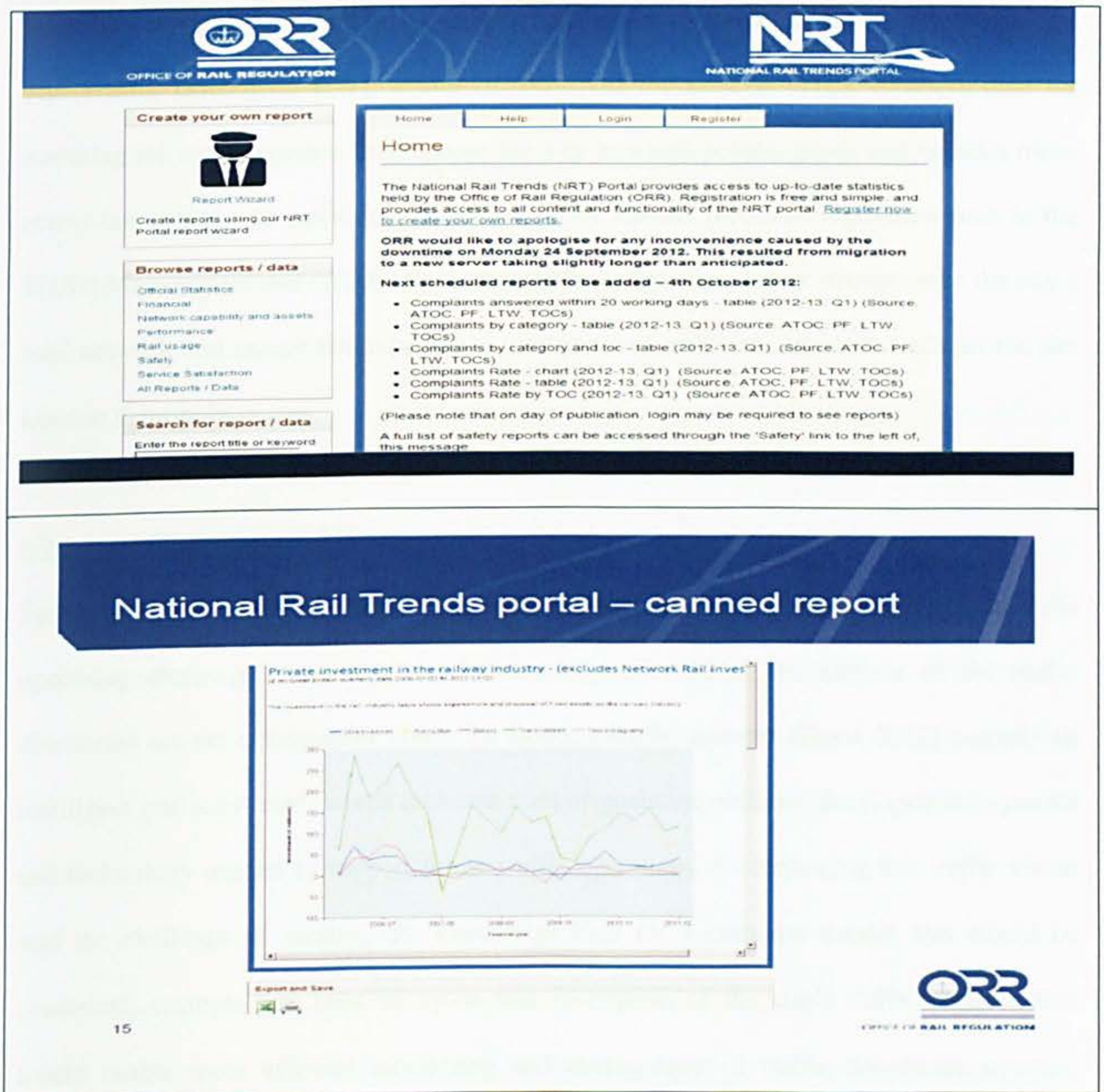
(2) Easier and quicker access to data and efficiency savings from online reporting.

(3) Timely provision of disaggregated data and resources freed up from automation.

(4) Breadth and depth of data now increased and reputation enhanced by openness.

The figure below (6.2) shows the new ORR BI system web portal for data access.

Figure 6.2: ORR Business Intelligence Web Portal.



Source: Internal document, courtesy of ORR.

6.2.2: Transport for London (TfL)

6.2.2.1: Interviewee

The interview was conducted with the Principal Developer of the business intelligence system, at TfL's office in London. The interview lasted for about an hour and a half.

6.2.2.2: Organisation Background

London is a vibrant city of about eight million people, operating around the clock, with ever increasing demands for mobility, accessibility and real-time traffic management information. The Traffic Directorate (DT), a unit of Transport for London (TfL), is responsible for operating the traffic systems that manage the way in which people, goods and vehicles move across the capital. Its activities are backed up by various pieces of legislation such as the Traffic Management Act of 2004 to control traffic congestion, reduce disruption to the city's road network and ensure the expeditious movement of traffic on adjacent roads around the London metropolitan area.

6.2.2.3: BI Challenge at TfL

Faced with an increasing population, travel congestion, ageing legacy systems and the upcoming challenge of hosting the London Olympics 2012, the director of the traffic directorate set out a long-term vision for London traffic systems (Davis 2012) termed "an intelligent traffic system", which included a set of goals, capabilities, developments, systems and technology needed to support future traffic operations. Underpinning this traffic vision was the challenge of creating the knowledge base for a common dataset that would be consistent, accurate and have an up-to-date description of the city's traffic network that would enable more efficient monitoring and management of traffic directorate services, assets, projects and other business activities from a common dataset.

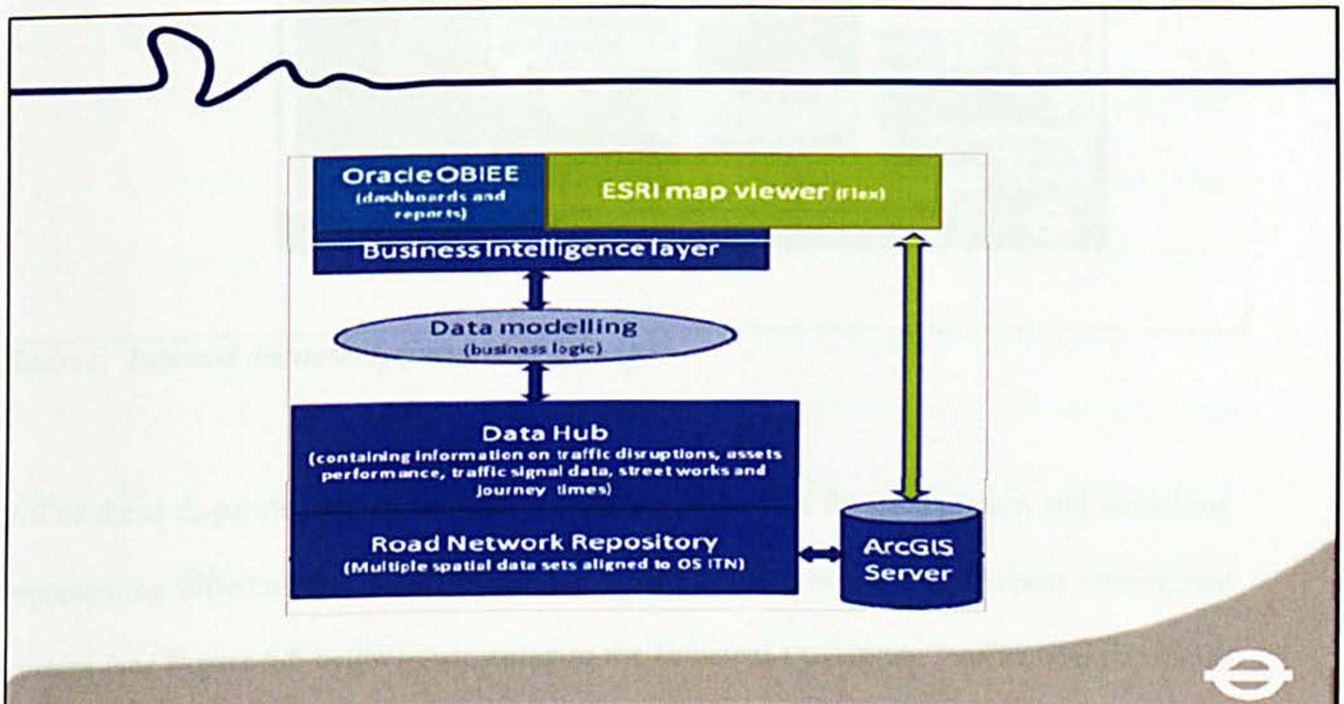
Technology was already being widely used in managing TfL traffic operations in London. In fact, the use of computerised dynamic traffic control systems was already well-established in managing, for example, the traffic lights at more than 6,000 traffic road junctions in the city, one of the largest traffic systems in the world. There were also computerised systems for managing and monitoring buses, congestion charge records, records of light timing changes, records of road work permits per year, and accident records, among others. However, much of these data existed in heterogeneous separate systems with little or no interaction or correlation between them. According to the Principal Developer of the business intelligence system at TfL, there "*were lots of data, but no centralised data control and reporting, no interactions between systems*". He further noted that, "*there were no clear way of defining and grouping data, and there were multiple definitions for the same thing, e.g., the word site might mean something different for buses, and another thing for traffic control, and even another thing for cameras*". He lamented that reports were repetitive, labour-intensive and some financial records could take up to four weeks, with several analysts working in different departments for example, in buses, tubes, cameras but all belonging to the same traffic directorate. According to him, there came the point when "*management thought enough was enough*". The major challenge therefore was working out how to collate all of these disparate and heterogeneous data sources into a unified traffic intelligence system that would act as an information exchange point for dynamic and real- time network monitoring, operational intelligence and asset management as well as providing advice to the public on travel information.

6.2.2.4: BI Implementation at TFL

In 2009, the Traffic Directorate of TfL embarked on its business intelligence project. As already noted, one of the major catalysts was the push from the London Mayor to automate and improve the provision of accurate traffic information in the run up to the London 2012 Olympics, which at that time was less than three years away. The business intelligence project was phased across three major stages: the first was a pilot or proof of concept utilising an initial set of data, with the aim of incorporating more data sets from other systems as the new BI system matured, stabilised and gained acceptance. The technical platform was an

Oracle software e-business intelligence enterprise suite. Oracle is one of the leading providers of business software (www.oracle.com). According to the project principal developer, *"we chose an Oracle BI suite purely because it integrated very well with the existing GIS data mapping system that was already in an Oracle platform which was a major data feed to the BI system"*. The Oracle BI suite incorporates a front-end business intelligence presentation layer in the form of an Oracle dashboard, Oracle reports and an Oracle map viewer, including Oracle Hyperion data analytics. There is also a data modelling (middle) layer that undertakes business logic of data aggregations and measures, including aligning for example, data facts to dates and locations. Finally, there is an enterprise database repository, referred to as the "Data Hub", in the TfL BI architecture, with an initial two terabytes of data storage. This is the centralised data repository for traffic disruption information, asset performance, traffic signal data, street works, journey times, and other multiple spatial datasets aligned to the system. It also undertakes data extracts and loading processes.

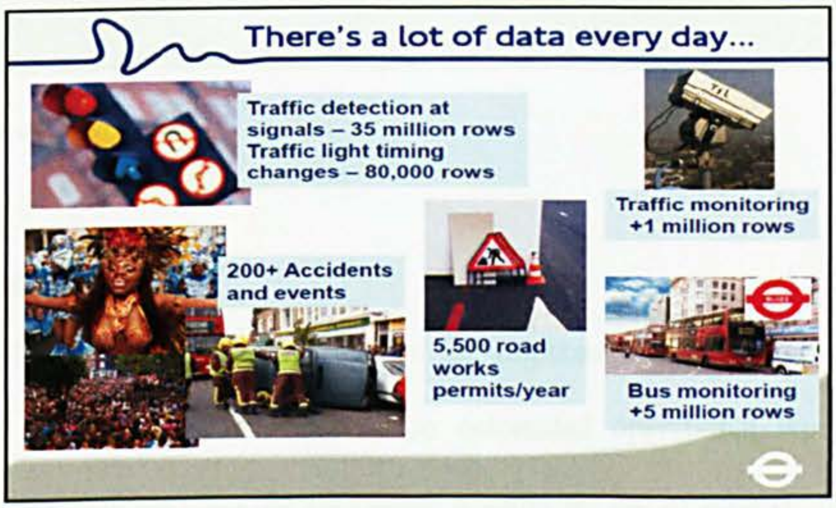
Figure 6.3 TFL Business Intelligence System Architecture



Source: Courtesy Directorate of Traffic Transport for London.

The TfL BI system combines data from seven different operational systems including data from traffic signals, congestion charges, road work permits per year and bus monitoring records. It also includes a geometric information system (GIS) that maps geographical spatial data in relation to space and location with other internal operations data. To illustrate, there are data on traffic detection at signals that include about 35 million records per day, data from traffic light timing changes that include more than 80,000 records a day, more than 5,500 records of road work permits per year, more than 5 million bus monitoring records, and data on traffic monitoring records on about 6,000 traffic road junctions, totalling in excess of ten million records. Table 6.4 below succinctly illustrates the data challenges at TfL.

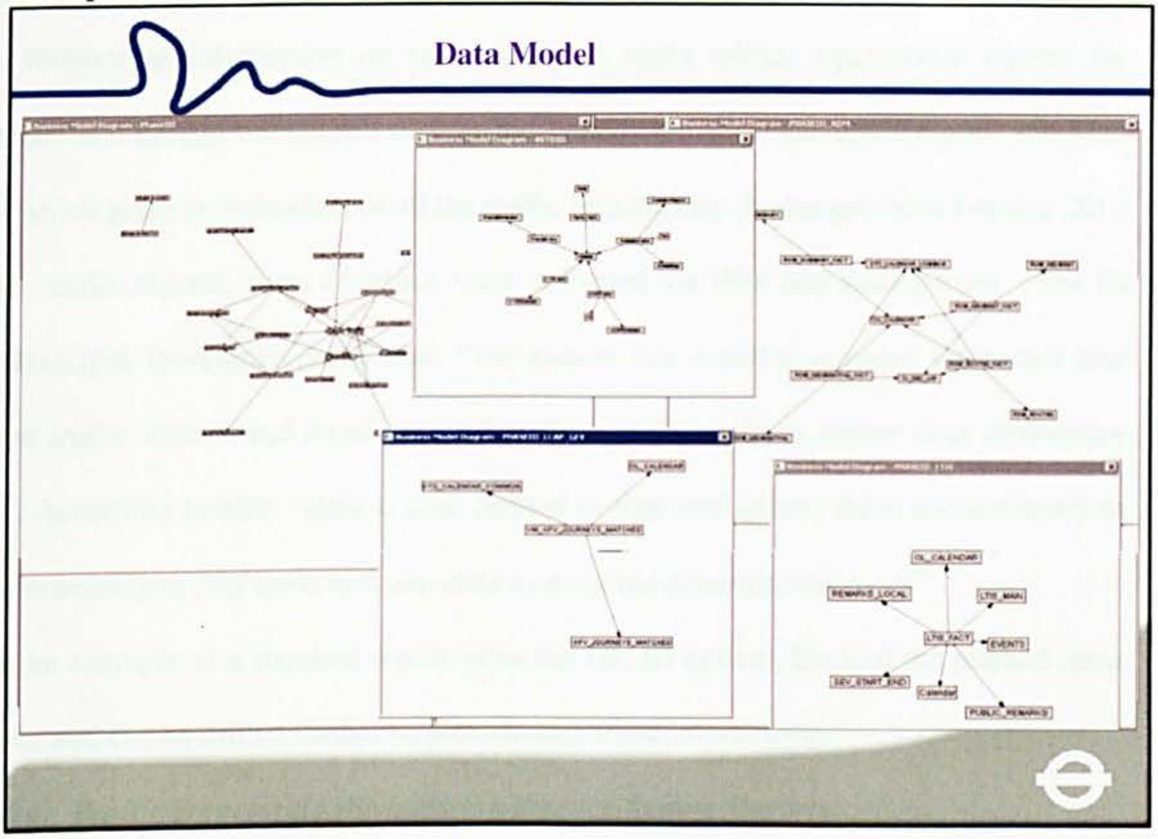
Figure 6.4: Data challenges at Transport for London



Source: Internal document, courtesy of TfL-DOT

All of these disparate data go through a complex process of data integration and modelling representing different data sets for different business units, in the TfL business intelligence system (see Figure 6.5 below). According to the Principal Developer, "*we worked flat out to integrate all of these disparate systems into coherent, holistic and common standards of operational data on traffic intelligence for managers, operational staff and executives*".

Figure 6.5. Spatial Data Modelling at TfL



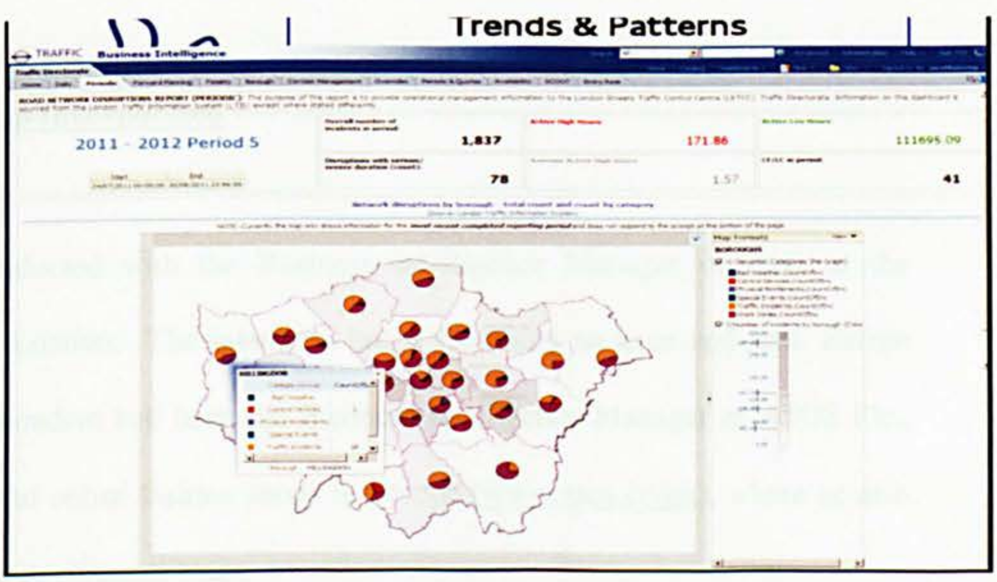
Source: Directorate of Traffic TfL

<u>6.2.2.5: BI Benefits at TfL</u>

According to the BI system Principal Developer, the implemented business intelligence system has brought benefits, one of which is an automated operational reporting and intelligence system. He indicated that the BI system actually set out to achieve three major things, namely to *"draw intelligence from historic data, undertake periodic changing reports and do some form of predictive analysis, and these have been achieved.* He also noted that initially the "*reports were repetitive, labour-intensive and static, with delivery times in weeks for major reports by which time some would have become irrelevant on arrival.* But with the new BI system, he indicated that they are now better able to capture, store, process, and analyse data more effectively. He went on to say, *"we have been able to realise the value of our data as an asset"*. Data and information are now presented via the business intelligence portal in the form of spatial and network traffic operations reports; traffic trends and patterns reports; monitoring information on the impact of street works; operational reports for stakeholders and decision managers such as the London corridor manager's report; and Map Widget, which gives an indication of all the traffic into the city. It also provided London 2012 Olympics traffic reports, some of which were delivered via iPad and smartphones. The BI system Principal Developer noted that, *"the system has enabled a more integrated and intelligent traffic system and freed up analyst time to do analyses rather than developing reports"*. According to him, *"data is now defined in time and space; there is consistency in data and comparison, and users now see data as a valued departmental asset"*.

Below is an example of a standard report from the TfL BI system. Each of the marked spots is dynamic and can be drilled further to provide additional information.

Figure 6.6: Traffic Directorate Business intelligence System Reports.



Source: TfL- Directorate of Traffic Operations

Other specific achievements with respect to the BI system implementation according to internal project documents (Duffield & Westhuizen, 2012) included:

(1) The BI system is now actively used to support business decisions. It is accessible online and is very responsive.

(2) Support for customers self-service.

(3) Value for money and is an award-winning project within Transport for London.

In respect to the 2012 Olympic Games,

(4) No Games event time delayed, nor were athletes or officials late for any event due to delays on the road network.

(5) It achieved the objective of keeping London moving during the 2012 Olympics Games.

There have also been other unquantifiable benefits of the system resulting from a co-ordinated approach to traffic operations across the whole of the London metropolitan area, and economics of scale from managing the network centrally and more coherently.

6.2.3: Organisation: Gap Incorporated

6.2.3.1: Interviewee

The interview was conducted with the Business Intelligence Manager of Gap, at the organisation's office in London. The interview lasted for about an hour and half. Before coming to Gap, the respondent had been the Business Intelligence Manager at ASOS Plc., one of the most successful online fashion shops in Europe (www.asos.co.uk), where he also headed ASOS's business intelligence team.

6.2.3.2: Organisational Background

Gap is one of the world's leading fashion retailers, offering clothing, accessories and personal care products for men, women and children under the Gap premier brand, and other company brands like Banana Republic, Old Navy, Piperlime and Athleta. Established in 1969, Gap products are available in about 90 countries worldwide through about 3,000 company-operated stores and over 300 franchise stores, including e-commerce sites. The company's total sales revenue for the 2013 fiscal year was about $15.65 billion (www.gapinc.com). Gap Europe, with its headquarters in London, manages the company's European operations.

6.2.3.3: BI Challenge at Gap

Gap operates in an extremely competitive fashion retail industry. There is increasing demand for more accurate, real-time decisions data about store performances and customer preferences. According to the BI manager, the ability to gain a greater insight across the item range is critical to improving customer satisfaction and retention and increasing net revenues. He noted, *"we wanted to better understand an item lifecycle with us...from when supply orders were placed to time of delivery, how long a product stayed in the store, up to the period of markdown or clearance...and make recommendations to pursue new supply orders or abandon an item line*". Some specific challenges faced by the European operations were:

- How and when to optimise markdown or clearance price setting per item and per store;
- How to maximise store revenues and sell-through rate;
- How to produce more dynamic, drill-down reports that gave a greater insight into items' lifecycle in the store.

Gap already had a centralised data warehouse technology platform, integrated with its customer relationship management system and other backend systems for reporting. The problem was that there were multiple reporting applications including a Cognos reporting tool, IBM Business Objects, and Essbase application, used for financial reporting. Other bespoke reporting tools had also been designed in Microsoft Access or Excel, each of which was used by a different department. According to the BI manager, some of these reporting tools did not have the capability to cope with the breadth and depth of data analysis required, and exploits the value of the underlying data. In other cases, data-rich reports were taking analysts 4-12 hours to produce, and in some cases, they were just *"static reports with no dynamic interaction with underlying data"*. In other cases, data were cut and pasted into Excel spreadsheets, with no in-depth analysis. Furthermore, he noted that depending on the design and configuration of the reporting tools, they offered different sets of reports and analyses even on the same set of data, and trying to correlate and compare reports for efficient sales and marketing decisions was becoming a challenge. According to the Gap BI manager, *"we wanted one version of the truth"*. There is also the additional operational cost of licensing, managing and upgrading numerous and duplicate reporting systems including attendant downtime. So, part of the Gap BI challenge was firstly to synthesise the information and intelligence reports used across the various departments and secondly, to consolidate reporting tools and save on IT operational costs.

6.2.3.4: BI Implementation at Gap

Around 2010, the new business intelligence manager initiated a new BI vision and strategy for the company's European operations. The business intelligence vision was to make business analytics a strategic differentiator and main competency tool in data management across the organisation. A new BI team was set up that worked with business partners from other departments within Gap (sales, marketing, finance, and inventory management) on how to enhance the automation, availability and quality of data analytics, including how to improve the business performance management reports required by business partners to define problems and take action. Gap already had a centralised data warehouse in place of about five terabytes, from which most of the existing reports were delivered. According to the BI manager, the new BI solution would need to be able to handle large amounts of data in terabytes that already existed in their centralised data warehouse system and optimise the business analytic requirement, albeit with faster response times. Thus, integration with their existing data warehouse and performance was a key requirement. After a careful BI software evaluation, a MicroStrategy business intelligence solution was chosen. The MicroStrategy product had functionality for data access, integration, analytics and reporting, including predictive modelling and forecasting. The initial deployment and test were undertaken with the assistance of the MicroStrategy consultants. Subsequent suites of performance metrics reports were developed by Gap's internal team on a wide range of interrelated activities such as: merchandising, inventory levels, demand trends, sales and store financial performance.

6.2.3.5: BI Benefits at Gap

According to the BI Manager, with the new MicroStrategy BI solution, reports were more automated, thereby cutting delivery times dramatically and offering the ability for dynamic drill-down. The BI manager noted that efficiencies and savings began within about three months of implementing the MicroStrategy BI solution. Furthermore, with extra time, the BI team has moved from being reactionary on report requests, to being proactive, meaning that staff can examine more data, and maximise the time spent providing value-added analyses and insights on data. The Gap MicroStrategy solution has leveraged the existing Oracle data warehouse technical platform, providing automated analytics, with advanced graphic functionality. It is highly efficient, timely and cost-effective and it produces high-quality reports and also saves on IT operations costs. According to the BI manager, some of the older reporting tools still exist temporarily, but the plan is to gradually phase out these legacy reporting systems as the MicroStrategy solution is deployed across the board.

6.2.4: Organisation: SAS Incorporated

6.2.4.1: Interviewee

The interview was conducted with the Pre-Sales Evaluation Manager of SAS UK, at the organisation's office in London. The interview lasted for about an hour and a half.

6.2.4.2: Organisation Background

SAS is an independent software vendor (ISV)[8], defined as specialising in the making and selling of software for niche markets such as business applications, engineering and medical applications. SAS prides itself on being the leading specialist provider of enterprise business intelligence and analytics software. Established almost 30 years ago, in 2013, SAS had an annual revenue of $3.02 billion (www.sas com). This fourth interview case study with SAS was carried out in order to have an independent perspective from a major business intelligence software provider on what is critical to successfully implement their software version of a business intelligence system.

6.2.4.3: BI Challenge at SAS

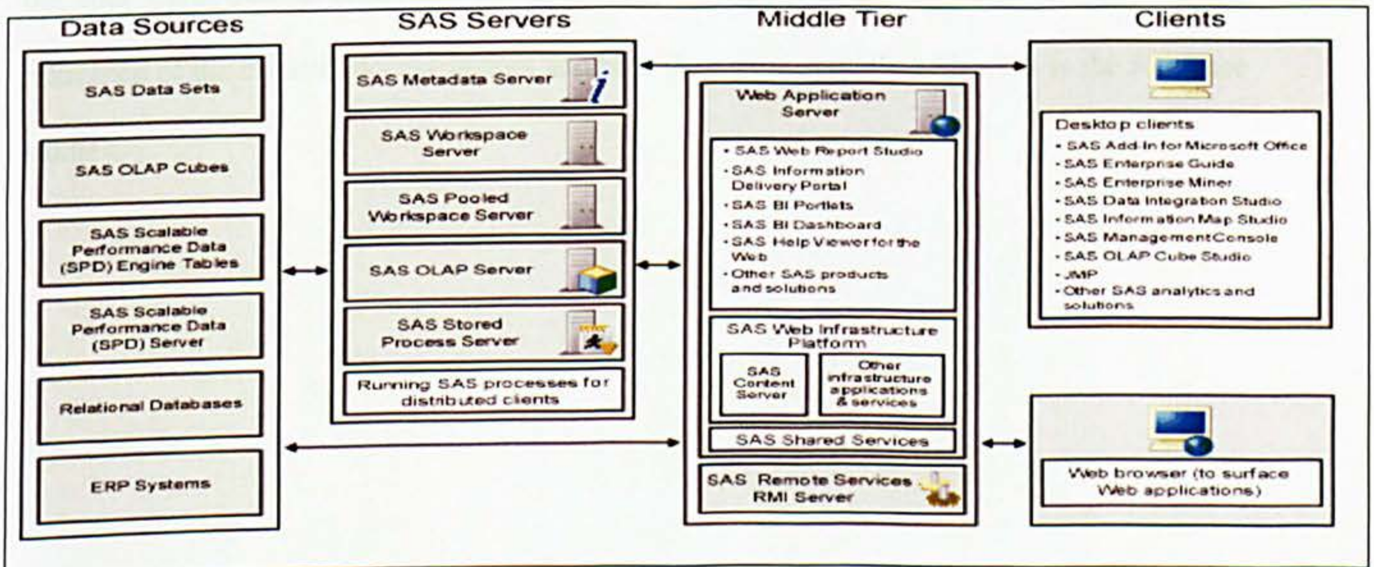
SAS UK is the headquarters of SAS's operation in the EMEA (Europe, Middle East and Africa). As a specialist BI software provider, it faces the increasing challenge of managing commercial relationships with tens of thousands of clients with regard to their BI project requirements, the deployment of SAS business intelligence systems, technical assistance, and software licensing and renewals. It also signs new clients and carries out training on SAS technology, both online and offline, at the SAS "university" at its regional head office in Marlow, Buckinghamshire, UK.

[8] An Independent Software Vendor (ISV) is a company whose primary function is the making and distribution of software that runs on different computer hardware and operating systems, as distinct from computer hardware manufacturers. Retrieved Gartner Consulting; 25 June 2013;http://www.gartner.com/it-glossary/isv-independent-software-vendor

6.2.4.4 BI Implementation at SAS

The SAS business intelligence solution is made up of four different integrated tiers of technology architecture components. The first is the data sources tier, which stores enterprise data in any relational[9] database management system, such as Oracle, DB2, Teradata, Microsoft SQL Server, Sybase, other ERP system databases, and SAS database formats. The second tier is the SAS server process architecture, which handles different service processes such as the SAS Metadata Server, SAS OLAP Server, SAS Workspace Server, SAS Pooled Server and the SAS Stored Process Server. It is in the server tiers that different business logic, measures and aggregations are performed on the stored enterprise database. The third tier of the SAS architecture is the SAS Web server layer, which passes and processes requests to and from other SAS middle tier servers. The final tier of the SAS technical architecture is the client layer, which provides SAS users with desktop access to the business intelligence data. In the SAS technological offering, additional functionalities and customisation may be required to suite client's business process. Figure below (6.8) is the SAS technical platform.

Figure 6.8: SAS Business Intelligence Technical Platform Architecture.



Source: SAS Incorporated.

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[9]Relational Database Management System RDMS. A term introduced by E.F. Codd (1970), which describes how a set of related data can be stored in a table, with multiple tables making up a single database. This is different from flat-file databases, where a database is contained in a single table (Moss & Atre, 2003).

6.2.4.5 BI Benefits at SAS

The SAS business intelligence system plays a large part in managing the complex commercial relationship between SAS and its clients with regard to their different profiles, project needs, levels of engagement, and training and certification. This is also done in different time frames, across three continents. The SAS business intelligence technical solution, according to the Pre-Evaluation Manger, is unique to SAS and has been deployed to thousands of customers worldwide in sectors ranging from banking, to insurance, media, pharmaceuticals, consumer products, energy and utilities, the public sector, retail, education institutes and telecommunications, among others. He noted that the "*SAS software is flexible and adaptable to every industry and can assist them in transforming their data into predictive insights on company performance, customers, markets, risks and more*". The ultimate objective of the SAS business intelligence solution is to assist organisations in maximising the benefits from their information assets in order to realise their key business objectives.

Table 6.1 below presents a background summary of business intelligence implementation in the four participating organisations examined above, and the next section, discusses the relevance of the critical success factors and how they were actually addressed in the four case studies.

Table 6.1: Summary Background on Business Intelligence Implementation

Summary Background of Case Studies				
Background Information	**Participating Organizations**			
	UK Office of Rail Regulator (ORR)	**Transport for London TfL**	**GAP Plc.**	**SAS Plc.**
Industry	Railway	Railway	Major Fashion Retail	Independent Software Provider ISV
Ownership	Public company	Public company	Private Listed company	Private Listed Company
Why they Implemented BI System	• To integrate and standardized • To achieve cost & time efficiency • To achieve cost & time efficiency • Better data insight and analysis • Better Data Reporting &Visualization • Better insight on railways performance	• To integrate intelligence traffic system. • To achieve greater reporting efficiency • To reduce traffic in London Olympics • To achieve better data insight and analysis • To enable better data presentation. • To achieve traffic data synergies • To provide reliable transport information. • Better insight on London traffic networks.	• To achieve better data insight\analysis • To enable better data visualization • To archive better insight on store & product performance. • Need to remain competitive • To respond factor to market dynamics • To achieve cost & time efficiency	• To manage SAS clients engagements • To harness data assets potential. • To provide better data analysis • To provide better data visualisatio. • To provide information on total client engagement • To provide better access to shared information
BI Implementation Challenges	• Numerous disparate database systems • No defined process & data standard • Manual data processing &Reporting • Duplicated redundant data • Perception of poor data quality. • Heterogeneous data supplied by different railway operating companies.	• Big data challenge of size, variety and velocity • Isolated disparate data systems for buses, traffic lights, congestion charges, trains etc. • Disparate data going back thirty years.	• Multiple and duplicate Reporting tools. • Manual and non dynamic Reporting • Standards reports took weeks.	• Integration of disparate data. • Management of data complexity issues • Reduce Multiple Reporting Tools
BI Technical Solution	• Microsoft Technical Platform; • Microsoft SQL Server BI software suite • Microsoft Reporting Service • Microsoft Analysis Services • Drupal • Enterprise Data Warehouse apprx. 500GB	• Oracle relational dataabse platform. •Hyperion Business Intelligence Suite. •Oracle EBIE (Oracle e-business intelligence enterprise suite. • Enterprise Data Warehouse apprx. 2.5TB	• Oracle Technical Platform. • MicroStrategy Business Intelligence Suite • Centralized Data Warehouse apprx.5TB	• SAS Technical Platform; • Support major Relational Database backend • Centralized Data Warehouse
BI Benefit	• Greater trust in data • Easier and quicker to access data • Resources freed up from automation. • Reputation enhanced by openness. • Enhance stakeholder relationships • Efficiency savings from online reporting • Redesign of job roles & cost savings	• London keeps moving during Games • Timely Olympics games reporting. • No Games time event delayed. • Better monitoring of Works impact. • Data now more valued as asset • BI is accessible and responsive • Support for customers self-serve • Value for money and award winning	• Saves time responding to queries • Less time spend by analyst to locate data • Ability to comprehend data differently • Better support for business decisions • Software procurement savings	• More efficient ways of working • Cost & time efficiency • Collection of knowledge in one place • Instance access to information • Efficiency customer satisfaction • Improve services to customers
Implementation Approach	• Completely Outsourced (IMGroup) • Externally hosted BI system.	• In-housed team effort • Internally hosted BI system	• Both In-House & third party consultant	• Internal deployment • Internally hosted BI system.

Source: Own

6.3: Critical Success Factors Analysis in Case Studies

The last section discussed the rationale for implementing business intelligence systems, how the BI systems were implemented by the participating organisations and the challenges involved. This section reflects on the relevance of the critical success factors and their applicability in these case studies. The discussion is presented in four major critical factor categories, namely: organisational related factors, process related factors, technical related factors and user related factors, in line with the factor naming and interpretation (see Section 5.5.5) that was the outcome of the factor analysis undertaken in Chapter five.

6.3.1: Organisational Factors

Business intelligence implementation involves an enormous amount of money, people and resources, and all of the participating organisations in the study strongly agreed that having a clear business case, a strong management support, and an executive level sponsorship, are paramount to facilitating continuous funding, monitoring and guidance for the project.

The business intelligence manager at the UK Office of Rail Regulation (ORR) noted that the business case was extremely important to obtaining executive sponsorship and management support to provide resources for the project. He noted that, *"if one cannot clearly articulate a clear business need for the BI solution, then they should not even start it"*. He also stressed that business intelligence is not just another IT fad, which organisations had to have. He noted that in their experience as a public sector organisation, they had to justify the benefits of any major project, not only within the organisation, but also to the public. He pointed out that project financing at the ORR goes through different committees and approvals from management committees to executive level committees and expenses have to be approved in advance of the financial year. According to him, *"we undertook the net present value NPV of* *the BI project, where we demonstrated that over a period of five years, there would be significant savings from making five roles redundant, which could be deployed to other uses within the organisation"*. On executive sponsorship, he noted that every major project at the ORR has to have a Senior Independent Responsibility Owner SIRO, which is an executive level position that has ownership of the project at the board as the sponsor. Thus, he noted that the written business case is important in clearly articulating the benefit of the BI project, which in turn secures the executive level sponsor (SIRO) and management support. This subsequently guarantees resources for the project, and all of these factors reinforce each other.

At Transport for London (TfL), the business intelligence project was part of a bigger project of a "London intelligence traffic vision", articulated by the director of the traffic directorate, which had become imperative given the upcoming London 2012 Olympics. It had direct approval and support from the top management. In fact, the executive sponsor was the head of the traffic directorate, who maintained a very keen interest in the project throughout. According to the TfL Principal Developer, while they did not undertake a monetary calculation on return on investment, *"the benefits were well articulated to all stakeholders, and we had management support for the project"*.

Gap's business intelligence manager also drew on his experience as the business intelligence manager at ASOS, a major online UK fashion retailers before moving to Gap Plc, indicated that the business case was crucial to justifying the investment, and organisations need to know what they want from a BI system. However, he pointed that, *"initially all the benefit may not be very clear, and the BI system is only as good after the project is delivered"*. With regard to the executive sponsor, he noted that, *"you cannot undertake BI as a department* *project; it cuts across departments and this is where the executive sponsor or champion is important*".

SAS Incorporated, a major independent business intelligence software provider, has great experience of implementing such systems at client sites. According to the SAS respondent, a good business case is important in order to justify return on investment and funding especially for very capital intensive and big business intelligence projects. He noted that SAS, as a software provider and implementer, could help clients with feasibility and return on investment (RIO), in order to obtain funding approval at board level. In the same vein, he stressed that having a project sponsor or champion in an executive level position within the organisation is also very important to the project's success. In fact, according to him, "*SAS will not undertake an implementation for a client if they have no identifiable project sponsor*". This, he said, is important, to avoid multiple or conflicting authorities and internal politics, which can sometimes cripple a project.

<u>6.3.2: Process Factors</u>

All of the interviewees strongly expressed the relevance and importance of having a structured project planning and management, effective communication with all major stakeholders and, a well-articulated process of managing changes and expectations.

At the UK Office of Rail Regulation (ORR), project planning and management was seen as a critical factor for their success. The ORR had a project steering and management committee that consisted of the project sponsor\senior responsibility owner (SIRO), other executive board members who had a primary interest in the BI project, the project manager, the business intelligence managers and others. According to the ORR respondent, "*there were* *clear project implementation schedules and planning managed by a dedicated project manager who was Prince2 accredited* ". PRINCE2 is a process-based project management methodology for planning, monitoring and directing large-scale projects. Developed by a UK government agency and used as the de facto standard for public sector projects, it has also been widely adopted by the private sector, including for information technology projects in the United Kingdom (www.ogc.gov.uk/prince2). At the ORR, the project manager was responsible for the project scope, daily project progress monitoring, managing checkpoint meetings, managing project risk logs and compiling project documentations. The ORR business intelligence manager noted that one of the criteria for choosing their outsourced implementation partner was that they were familiar with and would adopt PRINCE2 in their approach. This helped to facilitate the overall project management from both the client's and the outsourced partner's perspective. On change management, the ORR respondent noted that the project manager was also responsible for managing changes and deliverables from the outsourced partner, including managing internal user acceptance testing of the delivered tasks.

Transport for London (TfL) also had a dedicated project manager who managed the resource requirements between the business and IT department for the project delivery. The TFL respondent noted that they had also adopted the PRINCE2 methodology and the project manager was PRINCE2 accredited. According to the TfL respondent, *"they had very short delivery time scales, and this had to be managed within the project"*. The project manager was responsible for communication, delivering resources, managing meetings, keeping project logs and documentation. The project manager was also responsible for managing changes across the implementation lifecycle, from the development stage, to the testing\user acceptance stage, and then onto the production or live environment. However, he indicated that initially, the change control processes were rather less rigid to allow for the flexibility they needed to deploy the pilot solution given the very short time frame.

Gap's business intelligence manager pointed out that, "*the installation of the BI software itself is not necessarily the problem, but managing the process*". He stressed that, "*getting the right technical software is not enough; organisations have to get their requirements right, and scope the delivery well*". In the Gap case, he noted that they adopted the Agile[10] project methodology deployment approach, where some finished report were delivered to be used, while remaining project report requirements are yet to be delivered. They had proper change management process in place, where each report suite was tested for user acceptance. Again, drawing on his experience at ASOS, he pointed out that a dedicated project manager who would plan, scope and manage changes was important.

The SAS respondent noted that project planning and management was critical and that SAS has all of its project managers working at client sites, attending client meetings, communicating business and IT requirements to and fro, and undertaking resourcing including monitoring project deliverables. SAS has a PRINCE2 accredited project manager for every client project. The SAS respondent remarked that SAS, as an international organisation, does have its own project management methodology, although it will work with any project management methodology adopted by the client. Accordingly, a structured project management approach is very important as this helps with communication, planning and resourcing, especially for big projects, although he acknowledged that the level of full project methodology adoption may not be necessary with small projects.

[10] Agile software engineering methods have recently emerged as a new and different way of developing software, seen as flexible and has the ability to respond to constant change, compared to the traditional methodologies. (Tsun Chow & Dac-Buu Cao 2007; http://www.agilemanifesto.org)

Communication with all stakeholders, including internal and external stakeholders, was also considered critical by the respondents. According to the BI manager at ORR, *"the first deliverable project initiation document (PID) from the consultants was awful, and we made it clear that we expected better"*. He also stressed that, *"communication had to be consistent especially when dealing with an outsourced implementation to third party consultants.* Project scopes, work packages and schedules have to be clearly understood to avoid delays.

At the ORR, there was a weekly project meeting and monthly executive board level reporting meetings. There were also other opportunities to talk about the project during staff meetings, in internal newsletters, and at internal presentations, to *"generate interest in the project"*, according to the ORR business intelligence manager. Externally, the ORR had constant meetings with the third party implementer and the independent railway data providing organisations (DPOs). All of these communications were managed by the project manager together with the ORR external affairs department, which set up meetings and communicated both ways.

At Transport for London (TfL), communication was initially rather informal. The actual BI team was a small internal staff and the project was a pilot. According to the BI system principal developer at TfL, *"we knew what we wanted, the time scale, and what to expect ... we were also a small team, and it was much easier to keep the communication and engagement"*. He further pointed out that they had a good project manager who was the interface between the team and management, and the rest of the IT department, and *"if people have any problem or clarification, they contact the project manager.*

The Gap business intelligence manager noted that organisations *"need to set the right expectations mechanism on what the BI solution will address"*. In their own case, they needed to consolidate multiple basic reporting tools, and create more dynamic, interactive and visualised reports, in order to get better visibility of the end-to end process across the buying to merchandising chain. Therefore, knowing what to deliver drove communication before, during and after the project across all levels and with stakeholders.

The SAS respondent noted that communication is a critical factor and there should be *"somebody that can communicate the technical issues to business and the business issues to the IT people"*. He noted that the IT technical specialists who implement business intelligence systems may have little knowledge of the business processes of individual organisations. He pointed out that they might be "*implementing an SAS solution in a bank today, and undertaking the same implementation in a retail industry in the next six months*"; the same software but in different industries with specific business processes. So there is the need to have someone who can comminute the business requirements to the IT specialists who carry out the implementation, and who can also communicate the specifics of the BI functionalities implemented to the potential business users, and obtain their feedback. The SAS respondent stated that the project manager would normally undertake this role or it would be carried out by a business analyst who is "*familiar and understands the IT and business worlds*". Communication, he further noted, is important in managing change and expectations, including monitoring scope. He noted that from experience with BI projects, there might be an agreement with a client to implement a piece of work and during the process the client might see further possibilities and functionalities that they want to incorporate as well. A problem arises when the client expects the new request to be part of the existing charge. Of course, if it is a minor request or change, it may not incur additional costs; however, there might be a situation where additional tasks are chargeable. This is why it is important that the project scope is well defined and agreed, and there is proper communication and change management process in place; such that additional work requirements are signed off, especially in a client-supplier relationship. He stressed that there has to be "a clear *point of contact and having a strong and structured communication process is crucial for success"*.

6.3.3: Technical Factors

The interview respondents strongly expressed the relevance and importance of having adequate technical infrastructure, efficient data integration and management, appropriate software selection and, the right skill sets to successfully implement a BI system. However, the respondents differed slightly with regard to how these factors were adopted in their projects.

At the Office of the Railway Regulator (ORR), business intelligence data came from 35 independent railway data providing organisations (DPOs). Their data came in different formats, with different ownership and control structures, all of which had to be properly managed, integrated and analysed to provide the required railway operational intelligence, as well as statistical and economic information to the public, decision makers and other government departments. According to the BI manager at the ORR *"it was very challenging and tricky"*. He further noted that *"we had to employ the Railway Statistics Management Group, an industry governance group established since 1966, to help push through the data required"*. He also stated that, *"we also set up a sub-group on data standards, comprising representatives from the data providing organisations (DPOs) on the data standard to submit, and we reviewed data stakeholders' concerns at these meetings"*.

Transport for London (TfL) had the same issue of data integration, with the added complexity of the share volume of data streaming through daily in relation to buses, traffic, cameras, and congestion charges, as well as spatial geometric information from the different units of the traffic directorate. According to the TfL respondent, *"there was a lot of data, and we were really concerned with the issue of data accuracy"*, as errors mean incorrect information being given to the public and that it is unacceptable. Furthermore, TfL had been the custodian of traffic data for more than 30 years, and there was the issue of which historic data was relevant to the project and from what time. He further noted that data ownership within TfL, whether for buses, cameras, congestion charges or traffic information, remained with the data owners at the different department and that there were initial resistance. However, they had to get them involved, and the fact that the BI project sponsor was the head of the traffic directorate did help in getting the required corporation.

Gap's business intelligence manager mentioned that the BI system is only as *"good as the data that comes in"*, whether from an operational data store or a data warehouse. Thus data quality and accuracy are fundamental. He noted that from a technical perspective, the BI principle function is the same for scorecards, dashboards and key performance indicators (KPIs). However, these technologies interact with data in various hierarchies and present the same data differently. He noted that in retail, business is very much interested in hierarchies and there are so many different hierarchies such as those related to inventories, products, brands, and head office versus regions, etc. However, underpinning all of these different BI technologies is data accuracy. He indicated that in their particular BI project, the data warehouse was already in existence, but they still had the task of designing new sets of data aggregations that would reflect new project reports and integrate the MicroStrategy BI analysis front-end application with the data warehouse. However, speaking from previous experience, the Gap business intelligence manager asserted that designing the data warehouse schemas of facts and dimension tables, designing the metadata[11], designing the data cubes that reflect the different aggregations and calculations of report hierarchies, and getting the data into the data warehouse, including cleansing, transforming, loading and ensuring data integrity, had been the most difficult aspects of the business intelligence implementation. He noted that these would normally take up about 80% of the business intelligence project effort.

The SAS respondent noted that in his experience, "*the amount of work in data cleansing and integration is often underestimated in BI projects, which is one of the reasons for failure*". He indicated that BI implementation cuts across departmental boundaries and organisations have to be well prepared for it. He stressed that organisations must be able to identify and understand data sources and know how to integrate the data into the business intelligence system. Data integration, according to him, is "*one of the most important factors, because garbage in equals garbage out*", which affects the quality and reliability of the BI system. The SAS respondent indicated that the SAS software has a special data integrator tool that can assist customers with data-related issues. However, customers still have to provide inside knowledge on what data exists, where it exists, and what it is used for, and these are practical challenges in a BI implementation that have to be addressed.

The respondents also stressed that having a reliable and efficient ICT infrastructure for the data warehouse and business intelligence readiness in terms of data storage capacity, servers and network performance, were not only pre-requisites for success, but that the technical infrastructure should also be flexible enough to accommodate future growth. At the ORR, the respondent noted that they needed this flexibility to scale their technical infrastructure and

[11] Meta data, also referred to as master data, describes how, when and from a particular set of data is collected, including how the data is represented. Metadata is essential for understanding information stored in data warehouses and is very important where information come from disparate data sources (Moss & Atos, 2004).

so they chose an externally hosted solution where they pay a monthly hosting and support fee, which "*works well without having to commit too much underutilised infrastructure initially*". He noted that at the ORR, there was a bit of controversy initially with the IT department who wanted it hosted in-house. However, they realised that because of the criticality of the BI system and portal reports, accessed by the public, "*we wanted that uninterrupted service*" that would most probably be provided by a third party service and hosting company.

The TfL BI project was a pilot, and had an initial delivery target of less than a year. Project managers were of the opinion that their existing IT infrastructure could accommodate the pilot deployment. However, the TfL respondent indicated they would have to provide additional infrastructure resources or move the backend system from the existing physical infrastructure going into the later stages of the project. The Gap business intelligence manager noted that with online retailing, Gap increasingly captured far more data on customer profiles and preferences etc. than ever before. He indicated that the Gap data warehouse was more than five terabytes in size and was still growing, and that therefore performance could deteriorate. As such, there was a need to scope the technical infrastructure for the exceptionally huge amount of data storage and traffic to cope with medium to longer-term growth. He noted further that one of their challenges for now is how to reduce data latency. He stressed that traditional BI systems were made up of historical data, but requests for up-to-minute data are becoming increasingly necessary for the BI system. However, for performance reasons, systems management do not want to query operational systems to get real-time data. Thus, he noted that a major challenge now is how organisations can get real-time data onto their BI systems without affecting the system's performance.

The SAS respondent pointed out that business intelligence systems could grow to terabytes (1,000 gigabytes) in no time, and some organisations' data are even approaching petabytes (approximately a million gigabytes), in the sphere of big data[12] analysis. These are examples of big data challenges with which business intelligence systems have to deal. These extremely large amounts of data result from continuous data gathering by organisations that would normally be followed by BI system performance degradation. He stressed that the importance of adequate and scalable technical infrastructure for business intelligence readiness cannot be overemphasised, and indicated that SAS normally work with clients to scope and evaluate their BI technical infrastructural readiness. He strongly encourages this especially at the beginning of a project.

On technical platform and software choice, all of the participating organisations highlighted different reasons behind their selection of software and technical platform. The ORR set out criteria for its selection and used the services of an external consultant to make recommendations on the selection process. The platform that was eventually chosen was Microsoft SQL Server business intelligence suite, which incorporates reporting, analysis and data hosting functionalities at a very competitive licensing cost. He also noted that it integrated very well with other Microsoft Windows technologies already in use in the organisation, with which users were already familiar. In addition, he noted that the Microsoft software licence was competitive and that the platform had a good reputation and efficient technical support, judging from other software experiences.

[12]Big Data (Laney Douglas, 2001) refers to the challenges of the increasing volume, velocity and variety of data; Gartner Group Inc. Retrieved 22, January 2012. http://blogs.gartner.com/doug-laney/files/2012/01/ad949-3D-Data-Management-Controlling-Data-Volume-Velocity-and-Variety.pdf

TfL choose the Oracle software platform together with Hyperion analysis software, also owned by Oracle. According to the TfL respondent, "*we used the Oracle BI suite purely because it integrated very well with the geometric information system GIS database and other major databases already in that platform*". Gap implemented the MicroStrategy BI integrated with their existing Oracle data warehouse backend. According to the business intelligence manager at Gap, one of the software selection criteria was a *"self-service BI capability that business partners could use without too much training"*. He noted that the MicroStrategy BI had a Microsoft Office suite add-on tool that users were already familiar with, and that they could take small chunks of data into a familiar Microsoft Office environment to work with if the need arose.

The SAS respondent indicated that their BI solution would integrate well with any existing technical platform whether that was Microsoft, Oracle, IBM or SAP, and mentioned that the technical platform was a choice for the client rather than the SAS software preference. However, he stressed that, "it *is important to consider the integration of tools and it could be a problem where the organisation has little understanding of the tools they select, as there are many software vendors pushing their products.* He further indicated that depending on the project, selecting one BI suite of functionalities enables better integration and is easier to implement successfully. He pointed out that BI vendor tools might do things differently. For example, data integration tools might represent data in different formats and might store data values differently in the system. Besides, there is also the issue of skills and having multiple software skills to implement different aspects of the project. Furthermore, there is also the issue of having to undertake multiple and different upgrade paths at different times, which could be disruptive in live environments. He observed that it could also be more costly when organisations mix and match software tools in their implementation. The benefits he noted of using one BI software suite are that upgrades are done once across the board, and in the case of SAS, they will normally supply the latest version of the software to the client at no extra cost as long as they pay their yearly software renewal fee.

All of the organisations attested to the importance of having the right technical skills on board and team coordination. Business intelligence implementation requires a very high level of technical skills, from data architects, and data analysts, to report developers, project managers, and system integration testers etc. (Moss & Atre, 2004). The ORR outsourced its implementation to a third party company, perhaps because they did not have all of the required technical skills in-house. TfL, understandably, used an in-house team because it is a much bigger and more financially stable organisation with a huge IT operation, compared to the ORR. Gap used a combination of an in-house team and the services of MicroStrategy consultants to implement their particular solution. The SAS respondent noted that they could supply the software to clients to implement themselves or they could implement the software for the clients. Alternatively, they also work with third party specialist IT Services companies or reseller partners, such as Accenture, Atos, Cap Gemini and others, who have pools of technical skills and experience with SAS software to implement a BI solution. He noted that over the last few years, they had begun to work more with specialist IT service companies to implement client BI SAS solution.

6.3.4: User Related Factors

All of the respondents attested to the relevance and importance of user participation, continuous user training and competence for the success of business intelligence implementation, and the need to optimise the use of the BI system to maximise the benefits of the implemented solution.

The Office of Rail Regulation (ORR) felt the need to engage users early on in the project, especially those whose jobs may be affected by the business intelligence initiative. The ORR involved them at the initial project scoping requirement meetings. According to the ORR respondent, "*the BI project was initially controversial because people were concerned about their jobs and felt they might not have the technical skills to fit into the new roles, so we got them (users) involved in every area; in the initial functional requirement analysis, in developing the report templates and taxonomies and how the reports should look like, and in assisting with developing the user acceptance scripts*". He further noted that as the project progressed and the users were shown the first set of reports and how the Web portal worked, they became more interested. Of course, he noted that there were people who were not engaged, but who would be affected by the BI project in the way they work. With regard to this, he said, "*we tried the carrot and stick approach*".

On staff training, the ORR initially sent the staff that would be affected by the BI system on a business intelligence fundamentals training course with an external IT training company. This gave them some background knowledge about what the business intelligence system was all about, including a look at BI reports, BI cubes, the BI dashboard, BI scorecards, BI key performance indicators (KPIs), and BI access methods (Atre & Moss, 2004). The ORR respondent stressed the need for constant training to maximise the benefits of the BI system. After the initial BI introductory training, the ORR also invited IMGroup, the outsourced company that had implemented their system, to undertake some in-house training with the staff on certain aspects of the solution.

At TfL, there was an initial engagement with the data owners from the various business units of the directorate and expected key users. According to the TfL respondent, "*most of the* *initial users were degree level users or more, who were line managers, project managers and engineer managers, who needed to analyse data and are involved in the decision process*". The goal was to get these power users to be able to create their own reports freely from the BI system without having to go through specialist report developers or analyst. To achieve this, the project lead identified key users who were knowledgeable about the data and the systems and then started training them internally on the new system, with a view to getting them to train other users in their departments who would use the system.

The Gap business intelligence manager, again recalling his days at ASOS where he was once the BI manager, noted that user participation is very important throughout the life of the project. He pointed out that, "*the business owner and users should drive the BI project, engage them, it should be them driving the delivery rather than IT*". He pointed to the need to create a BI advocacy group within the organisation, train them and then make them become trainers within the organisation, thus creating a whole knowledge sharing experience around the BI system and usage. He noted that they received initial in-house training from MicroStrategy on the new BI software, and emphasised the need for continuous training to optimise the benefits of the system.

The SAS respondent stressed that it is extremely important to involve "*users with experience and who are knowledgeable enough to give opinions on the qualities expected of the BI solution*". He noted that one of the major challenges and something that SAS does well is to bring together experienced users and managers and get them involved in the initial scoping of the functional requirements and what they consider necessary in the expected system. User training and competency, he also stressed, are important and, according to him, "*the earlier users are trained to utilise the system better*". He further indicated that with the SAS system, training had greatly improved, and SAS can now deliver specialist one-day end user training that familiarises them with the BI system and helps shorten the project lifecycle. With respect to the level of user technical competency, the SAS respondent noted that this is not really important with a SAS system. He noted that unlike ten years ago, "*most of the underling SQL code has now been embedded in the SAS graphic user interface GUI, and all users need is to be able to drag and drop*". However, he stressed that users still need to have some form of training on how to utilise the system, but importantly they must have an understanding of their data and what they are seeking from it. This also raises the issue of user intuition and the ability of the end-user to exploit and harness the data using different aggregates, measures and dimension tools provided by the BI system to extract implicit knowledge. It is important that users are able to undertake different simulations on the same dataset compare the results and make predictions, which is the essence of business intelligence. The SAS respondent noted that sometimes users and organisations are not even aware of the capability of the BI system in terms of what it can deliver, and when faced with another business need or requirement, they go on to implement another system, thereby duplicating systems and efforts and wasting resources. The SAS respondent indicated that it is important to undertake a pre-sale evaluation process in terms of what the clients want to achieve now, and what they possibly might want in the future.

Since implementing their BI system, each of the participating organisations has also faced different experiences and challenges. In 2011, the Office of Rail Regulation (ORR) set up a special data analysis unit to undertake in-depth research and data discovery for their BI system. The ORR respondent observed however that one of their challenges since deployment was that some users were still copying data from the business intelligence system onto a Microsoft Excel spreadsheet to manipulate it, instead of utilising the BI functionalities, which have better data analysis capabilities. The TFL respondent noted that they hope to undertake more in-depth data discovery and predictive analysis after this first pilot phase, as more data are brought in and the business intelligence system goes into its maturity phase. The Gap respondent noted that they would also want to undertake more data mining and predictive analysis than they presently do, but that some of these areas require specialist statistical skills, and this is an area that they are looking to develop further. The SAS respondent also remarked that completing a business intelligence deployment should not be the end of the process (in itself). He stressed that there is the need to revisit and reengage with organisations to evaluate how they utilise the implemented solution. He stressed that, "*post implementation reviews are not being done enough*". These could be an opportunity for clients to get further assistance from the BI software provider on how to increase the benefits from the implemented solution, and from the perspective of the BI vendor these could generate new business for them.

6.5: Chapter Summary

This chapter provided a detailed description of the case study interview data collected from four organisations that have implemented a BI system: the UK Office of Rail Regulation (ORR), the Traffic Directorate of Transport for London (TfL), Gap Plc. (a major fashion retailer), and SAS Plc. (an independent BI software vendor (ISV)). The chapter explored why business intelligence systems were implemented in these organisations, the business and technical challenges they experienced, the BI solution chosen, and the complexity of the implementation and how the system was implemented, including some of the benefits of the implemented solution. The next chapter reflects on the relevance of the critical success factors and how they were actually applied in the individual cases. In these discussions, the chapter offers a cross-analysis of the similarities and differences between the experiences of these four organisations, although it does not intend to generalise.

Arguably, the richness of the data collected and the in-depth description of the experiences of these high profile UK organisations have provided many insights into the understanding of the complex process of business intelligence system implementation and the applicability of the critical success factor constructs in real-life BI projects.

The next chapter presents a comprehensive discussion and analysis of both the initial survey findings presented in Chapter five, and the interview case study findings presented in this chapter, in order to discuss the study's overall findings, recommendations and conclusions.

CHAPTER SEVEN: DISCUSSION AND MODEL PROPOSAL

7.1 Introduction

This chapter provides a discussion, analysis and triangulation of both the quantitative survey findings and the qualitative interview case study findings within the context of the literature review and the research objectives.

The study sought to address the following key objectives:

- Explore the critical success factors of business intelligence system implementation.
- Assess their level of criticality
- Evaluate the strength of the relationship between the critical success factors.
- Establish the extent to which the critical success factors impact the BI implementation success.
- Examine which critical factor relates to which BI success measure
- Understand what drives an organisation to invest in such pioneering technology.
- Examine the major challenges in the process of BI system implementation.
- Propose a model to guide the process of BI system implementation

This chapter comprises three major parts.

The first section discusses the preliminary research findings: why organisations implement BI technologies and approaches to business intelligence system implementation.

The second part discusses the main research findings on the CSFs of BI system implementation in relation to the degree of criticality, the relationships between the CSFs, their impact analysis and contextual complexities.

The final part is a refinement of the initial research conceptual framework and model proposal.

7.2: Preliminary Findings

7.2.1: Reasons for implementing Business Intelligence Systems

The results from both the questionnaire survey and the interview case study (sections 5.3 & 6.2) indicated different reasons why the participating organisations had undertaken their business intelligence initiatives.

The survey data revealed that 80% of the respondents indicated that *support for better business decisions* was a major reason for implementing their business intelligence system. The other top six major drivers from a list of twelve in descending order of importance were: *increasing operational efficiency* (60% of respondents), *making better use of corporate data* (57%), *increasing business competiveness* (50%), *improving customer service* (45%), and *identifying new business opportunities* (44%) respectively.

Thematic content analysis of the four interview case studies (see Appendices 18, 19 & 20) on interview codes, links and segments espoused the constructs of "*data standardisation*", "*data integration*", "*data visualisation*", "*data insight*" and "*understand data better*" as some of the main drivers for BI implementation. Other BI drivers identified included: "*operational efficiency*", "*competiveness*", "*profitability*" and "*cost savings*". The UK Office of Rail Regulation (ORR) for example, indicated that "*data integration*", "*data standardisation*" and "*better data visualisation*" were major drivers for their BI initiative. Transport for London (TfL) indicated that they needed BI to "*gain data synergy across the traffic directorate*". Gap, the major fashion retailer, noted that they implemented BI to "*have a better view of store sales, performance*", "*optimise price markdown*" and "*eliminate multiple reporting tools and reduce IT costs*".

These findings corroborate earlier studies (Williams & Williams, 2007; Yeoh & Koronios, 2010; Olszak & Ziemba, 2012; Dawson & Van Belle, 2013; Naderinejad et al., 2014), which saw BI as a new technology and business process that harnesses disparate and heterogeneous organisational data to aid better decision-making process, and improve efficiency and business competiveness.

However, this study also noted that some benefits of business intelligence are intangible and, according to the participants, others are yet to be realised. This might perhaps be due to the strategic nature of business intelligence as an operational enabler across organisational functions and it could be difficult to distinguish its contribution from that of other activities. The implication of this is that where business intelligence initiatives are difficult to measure, it should be articulated as aiding the realisation of more tangible benefits in order to prove that it is worth the effort to justify the investment.

7.2.2: BI Success and Approach to BI Implementation.

The results from both the survey and interview case studies (sections 5.3 & 6.2) revealed that the participating organisations, who have different profiles, had adopted different approaches to their BI implementation.

The initial survey study sought to establish whether any statistically significant association exists between the reported BI success or failure, and some of the characteristics of the participating organisation, such as its primary business activity, and its approach to BI implementation, whether this was outsourced, undertaken in-house, or a combination of both. The results of the Pearson's Chi-square test indicated an estimate of ($\chi 2$=.221) at ($p = 0.895$) significance value, with respect to the approach to BI implementation and its success. A similar analysis of the association between the reported BI implementation success and the industry sector of the participating organisations showed Pearson's Chi-square test estimates of ($\chi2$=7.678) at (p = 0.567) level of significance. Both results are greater than the acceptable statistical significance value of (p = 0.05). Thus, we reject the null hypothesis and conclude that the association between the reported BI implementation success and some of the organisation's characteristics, whether by industry sector or their approach to BI implementation (outsourced, undertaken by an in-house team or both), is insignificant.

The thematic content analysis of the four interview case studies (see Appendices 18, 19 & 20) on interview codes, links and segments espoused the constructs of *railways, commerce, fashion retailer, independent software vendor ISV*, with respect to the characteristics of the participating organisations' industrial sectors. It also identified the constructs of *outsourced partner, IMGroup, combination of both and in-house team*, with respect to the BI implementation approaches. The findings, for instance, indicated that the ORR completely outsourced their BI implementation, while TfL used an in-house team, and Gap used a combination of an in-house team and the support of an external BI consultant. Incidentally, all of the participating case study organisations indicated that their implementation had been successful and they had realised benefits.

The implication of both of the findings seems to suggest that the success of BI implementation is not dependent, either on the organisation being in a particular industry or on the implementation being outsourced or undertaken by an in-house team. This gives more credence to the existence of other critical factors, whose combined effect influences the success of BI system implementation, which is the onus of this research. It also suggests that practitioners should weigh up the decision regarding whether or not to outsource their BI implementation very carefully, by considering all of the other related factors. However, it should be noted that these are preliminary findings, and BI outsourcing, for instance, is beyond the scope of this study. Further investigation might be needed to draw a more definitive conclusion on these two aspects of BI implementation in organisations.

7.3: Main Findings: Critical Success Factors of BI System Implementation

This study started with 15 most re-occurring critical success factors from about 30 critical factor themes used in 25 similar studies in the literature review, and it also added a new factor for validation in the initial research conceptual framework. These factors were then examined and validated with survey data for their importance and interrelatedness, which led to 14 exclusive critical success factors in four interdependent clusters that accounted for 61% of the total variances explained, of business intelligence implementation success. The CSFs were also examined in four interview case studies to gain further insight into their relevance and applicability in real-life project settings. The following sections thus discuss these final critical success factors within their interdependent clusters, triangulating both sets of research findings in line with the existent literature and the research objective.

7.3.1: Organisational Related Factors

The results of this study revealed that a clear business case, management support, an executive sponsor and team skills are extremely critical to business intelligence system implementation success (see sections 5.4 & 6.3.1). Yeoh and Koironois (2010) stressed the need to have a clear business plan and vision, aligned to the IT strategy. Similar emphases in terms of a clear BI strategy, goal and perspective were also expressed by Dawson and Van Belle (2013) and Naderinejad et al. (2014).

The survey findings revealed the interdependence of the organisational related factors, including their relative degree of criticality. The initial factor analysis indicated a factor loading of .761 on management support; .742 on executive sponsor; .595 on team skills, and .528 on a clear business case and vision, which are statistically significant factor loadings (Field, 2005; Hair et al., 2006). Further covariance analysis indicated that these three factors have a combined total variance explained of about 15%, of BI implementation success. The factor analysis also indicated that these four items form a factor cluster, and have a common underlying dimension. This suggests that these organisational related critical factors are more inter-dependent compared to other factor variables, and are most likely to positively or negatively influence the contribution of the other, in the BI implementation process.

From the perspective of specific BI success objectives, the survey findings of the bivariate correlation analysis identified sets of critical success factors that are most correlated with a particular BI system success attribute. For instance, the BI success attribute of *speed of information retrieval* is correlated most with the critical factors of *executive sponsor.* The estimate of the correlation coefficient is ($R = 0.422$) at ($p < .05$) statistical significance level (see Appendix 15). This indicates that *executive sponsor* has a significantly positive correlation with the realisation of the BI specific objective of *speed of information retrieval* at a 95% confidence level, which suggests an interesting connection that implementers could exploit in realising that particular BI success objective.

The interview case study provides further insight into the applicability of the organisational related critical success factors in real project settings. Thematic content analysis of the interview codes, links and segments (see Appendices 18, 19 & 20) espoused the constructs of: *"BI business alignment, net present value, harness data, better visualisation, operational* *efficiency, competiveness"* with respect to the theme of a clear business case. The 'lessons learnt' project report from Transport for London indicated that there was a clear business case for the BI initiative to synergise all traffic information in preparation for the London 2012 Olympics. Gap implemented its business intelligence system to eliminate *"multiple and duplicate reporting"* and get *"one version of the truth"* with regard to its sales and marketing operations, according to the BI manager. Furthermore, the Qualrus thematic analysis produced code constructs of *"senior responsibility owner SIROS, business side sponsor, executive level BI sponsor, BI centric project sponsor* ", with respect to the CSF theme of BI executive sponsorship. The interview case study also found that one of the early decisions to be made with respect to BI implementation is whether the organisation has the appropriate skills internally to undertake the BI project, and if not, whether to outsource. The Qualrus thematic analysis identified the use of technical specialist skills in code constructs such as: *principal developers, technical architects, data mining experts, report developers, project managers, testers* and others, most of whom are seasoned professionals with highly valued skill sets and recognised professional accreditations, such as PRINCE2. They are familiar with different implementation methodologies and software platforms. These findings are consistent with earlier studies on management support (Wixon &Watson, 2001; Yeoh & Koronios, 2010; and Dawson & Van Belle, 2013), executive sponsor (Harrison, 2012; Hwang & Xu, 2007; and Hawking & Sellitto, 2010), and team skills and the use of external consultants (Naderinejad et al., 2014).

However, the interview case study also found that the application of these critical factor constructs has its own contextual interpretation, complexity and challenges when it comes to business intelligence implementation projects. The study found, for example, that *management support* in a business intelligence system implementation context cuts across the entire spectrum of departments and business functions that are affected in terms of data inputs or outputs of the BI system. In the same vein, the *executive sponsor* in the context of BI implementation has to be someone who has the relevant clout across the various departments in the organisation to mobilise and galvanise resources for the project. The Qualrus interview code segment analysis and interpretation also found an association between the organisational related critical success factors of a clear business case, management support and an executive sponsor. For example, the business case justifies the cost and benefits, whether tangible or intangible, of the BI initiative, which encourages management support and ensures that the executive sponsor is in a better position to galvanise resources for the project (see Appendices 18, 19 & 20) on codes list, links and views.

The practical implication of both the survey and interview case study data findings is that BI project leaders must start by crafting a valid business case that indicates clear benefits. They must also be able to articulate the feasibility and how the BI strategy aligns with the overall business objectives. This in turn will secure commitment from top management and executives and thus the resources. Equally important are team skills, coordination, effective use of a staff reward system, efficient recruitment and a selection process that includes the vetting of third external party consultants. These are all important in building an effective team to deliver the BI project.

The other point that the study seeks to stress is the need to recognise the contextual differences, complexities and challenges when applying these seemingly familiar critical factors within the context of business intelligence system implementation as discussed. It is equally important to understand the CSFs' interdependent relationships. This suggests that every critical success factor must be addressed from within the context of its interrelated dimension cluster, to maximise its input in the implementation process, rather than from an individual, isolated and static perspective, which seems to be dominant in the literature (Hwang & Xu, 2007).

7.3.2: Process Related Factors

The study found the critical success factors of project management, change management, communication and user participation to be crucial to business intelligence system implementation success (sections 5.3 & 6.2).

The survey findings revealed the interdependence of these process related critical factors and their level of criticality. The covariance analysis indicated that these four factors had a combined total variance explained of 16.5% of BI implementation success. Further statistical analysis indicated that each had a factor loading of .779 on communication; .723 on change management; .659 on project management; and .500 on user participation, which is a statistically significant factor loading (Hair et al., 2006; Costello & Osborne, 2005). The factor analysis also indicated that these four critical factors constitute a common factor cluster, suggesting that they are interrelated and interdependent, with each impacting on the output of the other in the implementation process.

The results of the bivariate correlation analysis indicate, for instance, that the success attribute of *quality information* is correlated most with the process related critical factors of change management at ($R = .428$) and project management at ($R = .390$) respectively at ($p < .05$) significance level (see Appendix 15). This indicates a positive correlation at a 95% confidence level and suggests that the critical factors of *project management* and *change management* are most likely to have a greater impact on the realisation of the BI success attribute of *quality information,* which implementers could exploit to achieve that success objective.

From the interview case study, thematic content analysis of interview codes, links and segment (see Appendices 18, 19 & 20) espoused the constructs of: *clear project scope, project definition document PDD, project planning, realistic time schedules; work packages; tasks stream, PRINCE2, team meetings, lessons learnt reports and project risk log* with respect to the critical factor theme of project management. Further thematic analysis espoused codes, constructs and attributes of *change approval board CAB, change resistance, structured change* and *managing expectations* with respect to the critical success factor theme of change management. The interview data also identified the constructs of: *consistent communication, cross-departmental communication, team briefings, memos and updates on 'where we are'* with respect to communication. Further thematic analysis of the interview data produced the constructs of: *user acceptance testing (UAT), user design templates, user feedbacks* and *user functional requirement gathering* relating to the critical success factor theme of user participation. The importance of these process related critical success factors is consistent with earlier studies on managing change and expectation (Hawking & Sellito, 2010; Naderinejad et al., 2014), project management (Wise, 2007; Sangar & Iahad, 2013), communication (Hang & Xu, 2007; Yoeh & Koronios, 2010) and user participation (Olsak & Ziemba, 2012).

However, the interview case study also found great challenges with the application of these process related critical factors in BI system implementation. This study found that business intelligence system implementation is complex and involves the extensive use of different skill sets (see section 6.3.1), and the use of external consultants and coordination. The study respondents indicated greater communication challenges in engaging with different departments, translating their respective requirements into a holistic BI function, and engaging with third party organisations. These indicate greater complexity than in conventional, department specific information management system deployment (Atre & Moss, 2003). Furthermore, the study found that the BI projects were generally much larger IT projects in terms of resources and commitments, and extended over a lengthy period of time, on average about three years. Thus, the challenges of project management and change management were much more extensive compared to standalone application system implementation. This suggests that organisations may have to adopt a project management approach that delivers incremental delivery to keep up momentum. The interview case study, for instance, found that Gap Plc. adopted an agile project management approach, where a set of project BI deliverables were ready to be used by the business while the overall project was incomplete. TfL undertook a pilot approach with a few departments and had a plan to incorporate the rest of the organisation. The Qualrus interview segment analysis also found an association between the process related critical success factors of communication, project management and change management, which suggests interdependence (see Appendices 18, 19 & 20) on code lists, links and views.

The practical implication of both the survey and interview case studies indicates that organisations should adopt strategies of consistent communication highlighting the project's progress, share milestones and benefits, and inform employees of what will happen next which is crucial to the success of a BI project. Clear communication is absolutely paramount in order to set the right expectations, clearly articulate the project requirements, engage major stakeholders and encourage feedback. To further illustrate, the 'lessons learnt' project report from the ORR indicated that they had to ask their third party consultant to resubmit another project initiation document (PID) when a major piece of communication was not reflected in the BI initiation document. These findings support previous studies that noted many IT initiatives fail because of poor communication (Chua, 2005; Yoeh & Koronios, 2010). Furthermore, this study's findings suggest that organisations need to adopt a clearly defined process of involving users, managing change and the expectations of those who will be affected by the BI initiative. Appleton (1997) noted that organisations should not only recognise the need for change to stay competitive, but they should also know how to manage the change process in order to succeed. The findings also suggests that that project managers should find the best ways of engaging employees from the very beginning of the project, and it is extremely important for an organisation to understand its user base, its needs and what bothers users the most, before undertaking the BI initiative.

Another implication of the study is that organisations need to understand the inter-relatedness of the process related critical factors. The findings indicated that effective communication is absolutely necessary to highlight the benefits of the BI project, clearly define work packages, plan and monitor the project, manage change and get stakeholders' engagement, and these are mutually reinforcing activities. This suggest that each of the process related CSFs positively or negatively influence the other and needs to be addressed within the context of their relatedness, rather than individually, in order to maximise their input into the BI project.

7.3.3: Technical Related Factors

This study found that having an adequate and effective ICT technical infrastructure, undertaking an appropriate selection of software, the efficient management and integration of data, and employing a suitable implementation methodology are critical to BI system implementation success (see sections 5.3 & 6.2). This is consistent with the earlier studies of

Wixon and Watson (2001), and Dawson and Van Belle (2013) on data management; Hawking and Sellitto (2008), Yeoh and Koronios (2010) and Naderinejad et al. (2014) on technical infrastructure; and Harrison (2012) on software selection.

The survey findings indicate the criticality and interdependence of these technical related factors. The factor analysis indicates that these four variables have a combined total variance explained of 18% of BI system implementation success, and in fact, this is the highest contributor to the overall variance explained in the factor analysis solution. High factor loading suggests stronger factor contributions (Rummel, 2002). Further factor analysis indicates a factor loading of .749 on technical infrastructure; .723 on appropriate software selection; .698 on implementation methodology, and .583 on data management and integration respectively, which are considered statistically significant loadings (Hair et al., 2006; Field, 2005; Costello & Osborne, 2005). This also indicates that these four critical factors have a common underlying structural dimension and constitute a factor cluster. This suggests that these four critical factors are more interrelated and interdependent, compared to others, and are most likely to impact on the outcome or contribution of the other.

From the perspective of particular BI success attributes, the survey findings also point to a bivariate correlation of the likely impact of a specific critical success factor on the realisation of a particular BI success attribute (see Appendix 15). For instance, the BI success attribute of *advanced predictive analysis* is found to be correlated most with the critical factors of *implementation methodology* at ($R = .328$) and *technical infrastructure* at ($R=.313$) with a ($p < .05$) significance level. This suggests a positive correlation and an interesting connection and influence of these two technical related critical success factors, which could be harnessed with respect to the realisation of the BI system attribute of *advanced predictive analysis.*

However, it must be stated that this study sought to establish a correlation and not necessarily causality. There is no guarantee that purchasing the most expensive or complex software, or deploying a highly provisioned technical infrastructure, will guarantee BI implementation success, as found in Watson and Ariyachandra (2004). The emphasis here is that each critical success factor must be addressed not in isolation but within the context of its related factor cluster that influences its contribution and outcome.

The interview case study provides further insight into the applicability of the technically related critical success factors in real-life project settings. Thematic content analysis of the four interview case studies revealed significant data challenges espoused in textual constructs such as: *data volume, data velocity, variety, disparity, standardisation, complexity, data cleansing, transformation and loading ETL* (see Appendices 18, 19 & 20) on the interview codes, lists and links. Further thematic analysis revealed *data governance, meta-data modelling,* with respect to data definition, sources and meaningfulness. While each of the participating organisations had adopted different technologies and approaches to leveraging data-related challenges, they all stressed that data management and integration were critical to BI implementation success. The Qualrus thematic analysis also identified constructs related to the different implementation methodologies adopted by the organisations such as: *PRINCE2, Agile methodology, proof of concept, project pilot* and *phased implementation.* Further thematic analysis revealed the implementation of specific BI software platforms such as *Microsoft SQL Server BI suite; Oracle Hyperion BI suite; MicroStrategy BI;* and the *SAS BI suite.* Other themes revealed included having adequate and flexible *technical infrastructure* that could host a growing business intelligence data warehouse, speedy information retrieval, and an IT network that could accommodate huge data transfers between widely dispersed corporate data centres.

The interview case study also found that the application of these technical related critical success factors has its own contextual meaning, complexity and challenges when it comes to business intelligence system deployment, which is very different from conventional application systems. The case study found the challenges of BI data that included size (terabytes), variety, velocity and disparity. For instance, the data for the Office of Rail Regulation's (ORR) BI system came from about 30 independent railway data providing organisations called the DPOs. At TfL, the data for the BI system come from the traffic system, bus system, tube system, camera system, and congestion charge system, each of which are different units within the TfL organisation. The data volumes range from 500 gigabytes for the ORR, to 2.5 terabytes at TfL and about 5 terabyte for Gap (1000 gigabytes is 1 terabyte). To put these data figures into perspective, Adam Jacobs (2009), in his analysis of the pathologies of big data, noted that in the US Census, "*100 gigabytes is enough to store at least the basic demographic information—age, sex, income, ethnicity, language, religion, housing status, and location, for every living human being on the planet*" (p.1). Further thematic analysis identified other technical infrastructure challenges and readiness in the form of storage area networks (SAN), in-memory computing technology that can handle high data processing power, huge network bandwidths that can transmit large amounts of data reads and writes between corporate sites, and the challenges of 'big data' analytics. All of these are exceptional data and infrastructure challenges that come particularly with big data and business intelligence systems, unlike in standard information management systems. The Qualrus code segment interpretation and link suggests that the critical success factors of data management and integration are associated with adequate technical infrastructure, which is also associated with technical platform and software selection. Just to illustrate, the technical infrastructure should accommodate the data size and cope with its processing, while the software should support the business and functional needs of the data, all of which suggest that these technically related factors reinforce one another.

The implications of both the survey and the interview case study with respect to the technical related factors are multiple. Firstly, the study provides an insight into the fact that business intelligence implementation is heavily technology-dependent from both the software and hardware perspectives. Thus, choosing the appropriate software with vendor support, and having an adequate and flexible technical infrastructure that can support exceptional data growth, including new and evolving ways of information consumption such as cloud computing and support for mobile devices, is crucial to BI system implementation success. Also crucial is the implementation framework, whether in the form of a pilot project, prototype, or proof of concept, some of which were used in the case studies. These implementation frameworks enabled the project teams to demonstrate the project to top management, including evaluating the acceptance of the BI solution before replicating it across the enterprise. These findings support the work of Oliver and Kandadi (2006), who indicated that prototype and pilot projects are valuable low-cost and low-risk ways of proving the viability of an ICT project.

However, the study found that although data extraction, transformation and integration are facilitated by technology, stakeholders\management need to understand and get more involved in data related issues such as establishing source data, data ownership, data standardisation, enterprise data governance and the definition of metadata. These elements are all critical to the perception of data, its use and ultimately business intelligence system success and these issues should not be left to technical specialists.

The other and most important point from the perspective of this study is that organisations must recognise the contextual relevance, complexity and interdependence of these seemingly familiar technically related critical success factors when it comes to business intelligence implementation. This study has established that the four technical related critical factors of technical infrastructure, software selection, implementation methodology and data management and integration, are interrelated and interdependent. This suggests that they influence each other, work better together, and should be considered and implemented as a group, in order to maximise their input in the success of BI system implementation. This study also suggests that singular and static perspectives of critical success factor analysis found in information management system (IMS) research, although they may provide a great insight in understanding a particular process, are however inadequate in explaining overall system success (Bussen & Myres, 1997).

7.3.4: User related Factors

The findings of this study revealed that user related factors such as user training, competencies and user intuitiveness are crucial to the success of business intelligence implementation (sections 5.3 & 6.2).

The survey findings revealed the underutilisation of the implemented BI systems. This survey found great disparity between the implemented business intelligence functionalities and the extent of use. For instance, while about 90% of the respondents indicated extensive usage of *excel spreadsheets*, and another 60% indicated extensive usage *of standard BI reporting tools and dashboards,* less than 30% of the respondents indicated extensive usage of *BI mobile functionality* and less than 20% indicated extensive usage of *advanced predictive analytics and simulations* (see sections 5.3.4). Incidentally, the core BI analytical functions that provide greater benefits were found to be either fairly used or not used at all. These suggest the need not only for user training, but also for user intuitiveness and enthusiasm to exploit and harness the business intelligence system.

Further survey findings reaffirmed the criticality of the user related factors of training and user intuition. Both variables had a combined total variance explained of 12%, of BI implementation success. Interestingly, user intuition (the new variable), which was added to the conceptual framework for validation in this study, was considered more important than user training, according to the survey results. The initial factor analysis indicated a factor loading of .836 on user intuition and .554 on user training, both of which are considered statistically significant factor loadings (Hair et al., 2006; Costello & Osborne, 2005).

Thematic content analysis of the interview case study (see Appendices 18, 19 & 20) on interview codes links and segments, revealed the constructs of: *knowledge transfers, internal training, external training, user competency* and *BI professional accreditation* with respect to the theme of user training and competence. These findings are consistent with previous studies (Isik, 2009; Hawking & Sellitto, 2008) that stressed the importance of user training.

However, the interview case study also revealed that even the implemented BI system, which incidentally was deemed to be successful, was not optimally utilised. The respondent from the Office of Rail Regulation remarked, for instance, that one of their biggest challenges since implementing their BI solution was getting users to use the BI system optimally. He mentioned that some staff still export data from the BI system onto excel spreadsheets to manipulate rather than using the in-built BI functionalities. This, he noted, undermines the potential benefit of the newly implemented BI system and they have had to use a 'carrot and stick' approach to get the affected staff to use the BI system.

Based on these findings, it could be argued that user intuitiveness and enthusiasm and the ability of the end-user to harness and exploit the BI system play a significant role in the benefits derived from the system and the perception of success, even more than user training. Isik (2009) specifically stressed that a major difference between BI systems and other types of information systems is not just whether it is used, but how it is used, which can have a disproportionate impact on the benefits derived from the BI system. This is because business intelligence systems, unlike conventional processing information systems, are analytical systems that require elements of human thought and intuition to use the same set of data in different scenarios of "what if" analysis, to generate new understanding and business knowledge. Technology can provide notifications, monitor events, automate responses, and run predictive analyses, but for decisions requiring human thought, ingenuity and intuition are still essential (Howson, 2008; Isik, 2009). John Naisbitt (1982), a former chief executive of IBM and later Kodak, noted that *'intuition becomes increasingly valuable in the new information society precisely because there is so much data'* (p.178). What this study has done is empirically validate this notion, which it has found to be statistically significant.

The practical implication of the above is that organisations find ways not only to support BI usage and train users, but also importantly, to encourage user intuitiveness. As discussed in other sections of this study, efforts to achieve this goal include early user involvement in the BI project, continuous user training, the development of dedicated business intelligence competency centres and the setting up of BI advocacy or activist groups to promote the use of the BI system within the organisation. Other efforts to encourage usage could include a push from management and a rewards initiative for those who use and discover new business knowledge from the BI system. Also important is implementing BI solutions with increased user productivity in mind, developing easy to use BI systems without compromising quality and undertaking post-implementation re-evaluation.

7.3.5: Critical Success Factors not fully supported.

However, the study found that the critical success factors of *adequate budget* and *nature of organisation* had low initial communality and factor loading below .30 (see (Appendices 12 & 13), which is considered a statistically unacceptable level (Hair et al., 2006; Field 2005). This suggests that these item variables do not have sufficient correlation with other variables to warrant grouping and interpretation and should be dropped from the list of critical item variables in further analysis to improve the solution model (Williams, 2012).

These findings might seem rather surprising, especially given the importance of finance in any IT project initiative. But it should be noted that factor analysis measures the inter-item correlation with other items rather than the item scale on its own. Thus, while a variable like adequate budget had a high mean score of above 4.0 on a five-point Likert scale as a single variable, and could be seen as definitely important (Olbrich et al., 2012; Dawson & Van Belle 2013), factor analysis measures the sum of the item's total correlation with other variables, which was found to be weak in this study. This suggests that an increase in budget may not necessarily result in a corresponding increase in the contributions of other critical factors to the overall BI implementation success. This is one of the fundamental issues that this research is seeking to address. Existing CSF studies (Yeoh & Koronois, 2010; Olbrich et al., 2012; Dawson & Van Belle, 2013; Naderinejad et al., 2014) rank the importance of the CSF variables individually, either in case studies or using the variable statistical mean scores. While such approach is valuable, it misses the nature of the CSFs' interdependence and how they influence the other. This study looked at the sum of the critical success factors' interrelationship with other factors in a multi-variant dimension, and how this affected their input.

Another plausible reason might not be so farfetched. Gartner (2011, 2012, 2013) a renowned information technology research organisation, noted that business intelligence has consistently been one of the top ten IT project priorities over the last three years, and that BI spending, unlike that for other IT projects, was least affected by the last financial crisis. What this might suggest, in the light of this study's findings on budget, is that finance is important, but since organisations are eager to implement BI systems given their priority, they are prepared to be flexible on budget and are more likely to consider it as less of an issue.

On the nature of organisation in terms of the industry sector and whether it is private or public, the survey data preliminary Chi-Square test found no statistically significant association between reported BI system success\failure, and an organisation's industry sector (see sections 5.3.5 and 6.2.2). The subsequent factor analysis results indicate a low inter-item correlation and unsatisfactory factor loading, further confirming the initial Chi-Square estimates. The four interview case studies from two industries, with an equal mix of private and public organisations, reported successful outcome of their BI implementation. All of these suggest an insignificant association between the nature of an organisation and BI implementation success. A plausible explanation might be that business intelligence system implementation is still relatively new compared to other forms of information management system (Yeoh & Kirionois, 2010; Olszak & Ziemba, 2012). Thus, currently existing peculiarities in organisational culture and traits may not yet have been entrenched in business intelligence implementation projects to have a greater impact. Furthermore, most standard BI software platforms are very flexible and organisations could customise them to suit their specific business needs. This is in addition to the fact that most of the BI implementation professional and third party consultants have wide experience of working across industrial sectors and sizes, and are able to transfer their experiences flexibly to deliver BI initiatives.

7.4: Proposed Integrated Success Model of BI Implementation.

The next section basically combines all of the key research findings into a graphical model of BI implementation that could guide the process. The final proposed model is a refinement of the initial research conceptual framework developed from the literature review (see section 3.8) based on the empirical findings of the research. The model posits that to successfully implement a business intelligence system, organisations must understand: (a) the relative degree of criticality of success factors, (b) the CSFs' interrelatedness, and (c) which CSF relates to which BI success measure. It is also important to understand their contextual relevance in a BI implementation project. Essentially, the model proposes managing the critical factors and managing the corresponding success attributes. The proposed model builds on previous works on critical success factors in information management system research (DeLone & McLean, 2003; Wixom & Watson, 2001; Hwang & Xu, 2006; Yeoh & Koronios, 2010; Harrison, 2012; Olszak & Ziemba, 2012), discussed in the literature review (sections 3.3 to 3.7).

7.4.1: Overview of the proposed model

The model with its key components and relationships is represented in Figure 7.1 below. The difference between the proposed model and the initial conceptual framework is summed up as follows:

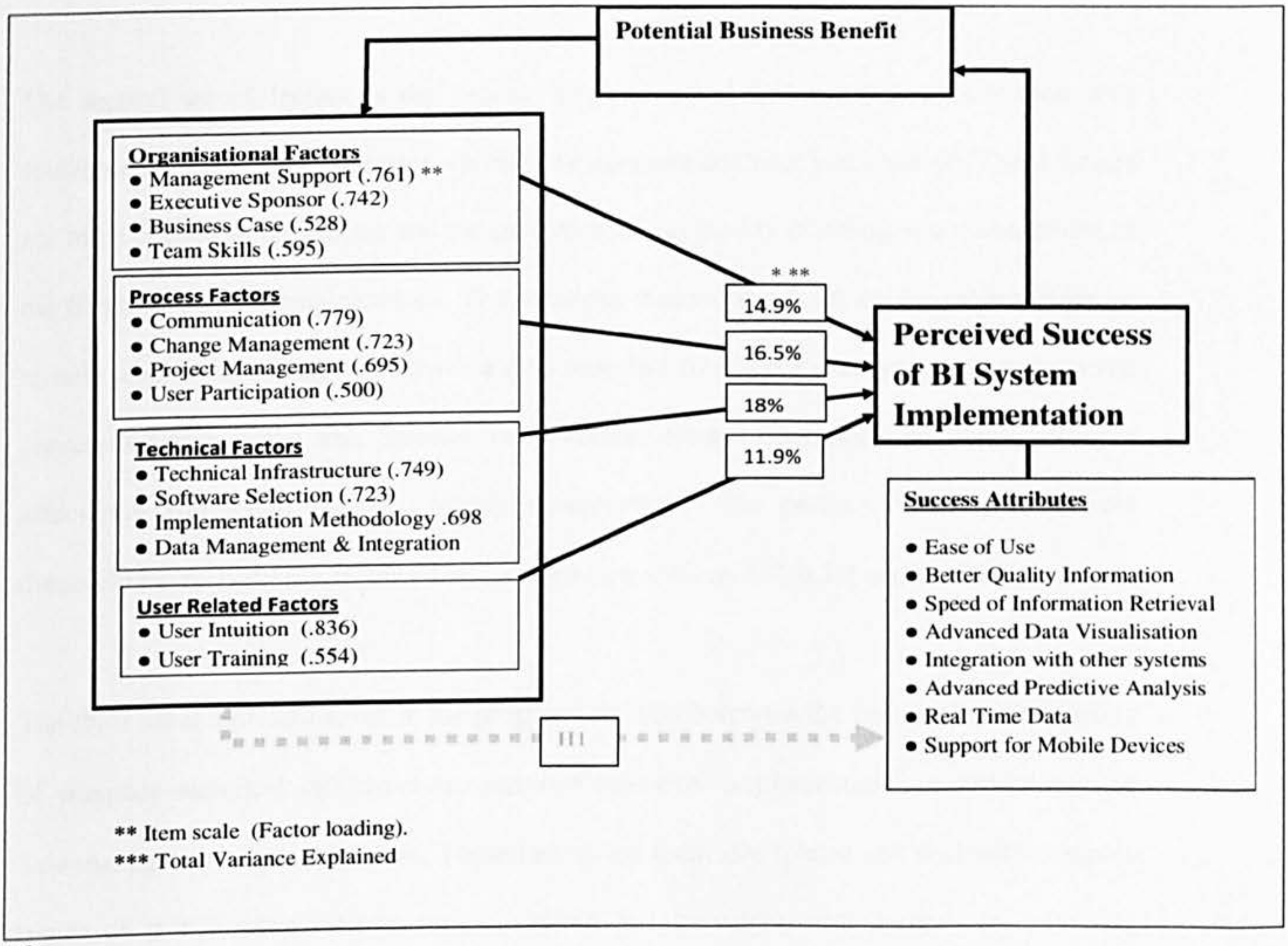
(1) The proposed model has fewer critical success factor variables than the initial conceptual framework.

(2) The proposed model has the item variables now explicitly grouped in four cluster dimensions of interdependent relationships.

(3) The proposed model establishes the factor loading, which represents the item scale or criticality based on their empirical relationship with others.

(4) The proposed model unambiguously establishes the explanatory power and the overall goodness of fit of the final solution.

Figure 7.1: Proposed Integrated Business Intelligence Success Model.



Own

The first major component in the model is the set of critical success factors (CSFs), which are the independent variables. These are the organisational related factors, process related factors, technical, and user related factors.

In the model, the organisational related factors are a clear business case, top management support, executive sponsorship, and team skills\use of external consultants. These are strategic factors that define and drive the BI vision and are more business and people related. The decisions taken at this level are the responsibility of top management and executives. The study found that the organisational related factors need to be addressed at the very beginning of the BI initiative. These were discussed extensively in the preceding sections (see sections 3.8, 6.3.1 and 7.3.1)

The second set of factors is the process related critical factors of communication with stakeholders, project management, change management and user participation. These factors are more related to operations and the processes of day-to-day planning and management of the BI project and communications. The decisions made at this level are the responsibility of middle level management, who have a clear mandate to enforce management decisions and processes taken at the top, monitor performance, control operations, set work priorities effectively and report progress to top management. The process related factors were discussed extensively in the preceding sections (see sections 3.8, 6.3.2 and 7.3.2)

The third set of critical factors in the proposed model comprises the technical related factors of adequate technical infrastructure, software selection, implementation methodology and data management and integration. These factors are tactically related and deal with complex issues of ICT hosting infrastructure, software and implementation techniques, including issues of data extraction, transformation loading and integration, as well as issues of data design, metadata definitions and data governance. These were discussed extensively in the preceding sections (see sections 3.8, 6.3.3 and 7.3.3).

The fourth set of factors includes the user related factors of training and user intuitiveness. This has to do with user competencies and how to maximise end-user usability and productivity from the BI system. These were discussed extensively in the preceding sections (see sections 3.8, 6.3.4 and 7.3.4).

The second major component of the proposed model is BI implementation success, which is the dependent variable. Specific attributes of BI success used in the model are: ease of use, speed of information retrieval, information quality, support for mobile BI devices, real-time data, advanced predictive analysis, and advanced data visualisation. The success criteria were discussed extensively in the previous sections (see sections 3.8 and 7.3).

At the top of the model is the ultimate potential business benefit that arises from the use of the business intelligence system such as: aiding an effective decision-making process, operational efficiency, reducing costs, or enhancing competiveness and profitability. All of these necessitate the motivation for the BI system in the first instance.

The model arrows indicate an association between the critical success factors and the main construct of BI implementation success. The model also postulates flexibility and progression, illustrated with a continuous circular flow that reflect the ever-changing potential business needs of the BI system, and a re-evaluation of the critical success factor requirements.

The strength of the proposed model is in the integration of the critical success factors and the BI success attribute into one comprehensive implementation framework. At the macro level, the model postulates the relative importance of the critical success factors. At the micro level, the model posits greater insight into the complex interrelationships and impact of the critical success factor elements on business intelligence implementation success. Overall the model is dynamic and implicit in its proposition is that organisations define the benefit expected from the BI system and manage the corresponding success antecedents (Hartono et al., 2008).

Finally, the model proposes an optimal strategy of BI implementation and could guide organisations in identifying the critical success factors, their interdependence and how to manage them in the BI project life cycle to ensure overall success.

7.5: Chapter Summary.

This chapter brought together the qualitative and quantitative empirical investigations. The analysis and interpretation of the findings were discussed, guided by the research objectives and the existent literature.

The chapter started by discussing some preliminary research findings in relation to why organisations implement business intelligence systems, and whether any significant pattern exists between reported BI successes or failures, and an organisation's industry sector or its approach to BI implementation which it found to be insignificant. The chapter then discussed the main theme of the research, namely the critical success factors of business intelligence implementation, by taking a triangulated approach under four major interrelated cluster dimensions found in the study. These are organisational, processes, technical and user related critical success factors. The study stressed the peculiar challenges and complexities in applying these critical success factor elements within the context of a business intelligence implementation project. It also discussed the interrelatedness of the critical success factors and the need to understand and manage each one from the perspective of its interdependent relationship, in order to maximise its input in the BI implementation project. The chapter also discussed the explanatory power of the CSF research variables used and the bivariate correlation of each set of CSFs and BI success attributes adopted in the study.

The final section was a refinement of the initial conceptual framework into a comprehensive success model of business intelligence implementation, based on an integrated perspective that could guide the process in real-life and increase the chances of BI implementation success.

CHAPTER EIGHT: SUMMARY AND CONCLUSIONS

8.1 Introduction

This chapter presents the overall summary and conclusions of the research, its contribution to theory and business practice, the limitations and directions for further research. The study sought to achieve the following research objectives:

- Explore the critical success factors of business intelligence system implementation
- Access their level of criticality
- Evaluate the strength of the relationship between the critical success factors
- Establish the extent to which the critical success factors impact BI implementation success
- Examine which critical factor relates to which BI success measure
- Understand what drives an organisation to invest in such pioneering technology
- Examine the major challenges in the process of BI system implementation
- Propose a model to guide the process of BI system implementation

8.2: Research Summary

The study started, in Chapter one, by highlighting the potential benefits of business intelligence in today's information management processes. It noted that business intelligence system implementation has consistently been in the top ten of IT spending priority (Gartner Research, 2011, 2012, 2013), as organisations seek to harness the potential benefits of disparate data systems, to aid decision making and gain competitive advantage. However, business intelligence system implementation is complex and costly with many cases of failures (Howson, 2008, Yeoh, 2010; Olszak & Ziemba, 2012). Yet few empirical studies exist on BI system implementation, perhaps due to its relative newness as a discipline and the fact that business intelligence has been led by industry rather than by academia.

Given this background, the study sought to investigate the phenomenon. It adopted a realist methodology research paradigm, incorporating a mixed methods approach in three distinct stages. The first was an extensive literature review of the phenomenon of business intelligence system implementation followed by the development of the research conceptual framework. The second was a survey of major stakeholders who are familiar with the process of business intelligence implementation. The third was an in-depth interview case study of four UK organisations that have implemented BI systems.

For the literature review, the study employed a systematic literature review approach (Denyer & Transfield, 2006; Levy & Ellis, 2006) with explicitly stated criteria for selecting, evaluating and synthesising literature items to include or exclude from the study. The first major part was an overview of the phenomenon of business intelligence including its evolution, definitions, the different schools of thought and perspectives; the BI system architecture and components; why organisations implement BI systems; and the problem of evaluating the benefits of BI systems. The study also explored what differentiates business intelligence systems from conventional information management systems, the future of the field of BI, and finally, the business intelligence implementation project life cycle. All of these were discussed to provide the theoretical foundation for the study.

The second major part of the literature review explored the constructs, arguments and models of BI system implementation, information system success, and the critical success factors of business intelligence system implementation, all grounded in the general theory and models of information management system (IMS) research. A critical review of the literature identified a wide range of thoughts and positions on issues. Different studies used different critical success factor variables, often depending on the researcher's perspective, and research findings were fragmented and isolated and it was difficult to identify a common set of critical success factor variables. Furthermore, the relationships between the CSFs have not been well explored; nor has the extent to which the identified critical factors unambiguously account for BI implementation success been well examined (Hwang & Xu, 2008). These issues constituted the research gaps and motivation for the study. Subsequently, the researcher undertook an iterative process whereby most reoccurring critical success factor variables used in the literature in similar IS studies, including measures of information system success, were synthesised and then employed to develop the research conceptual framework. This set the stage for the research design and fieldwork, which comprised a survey and interview case study.

The survey was on major stakeholders in UK organisations (N=102) who were familiar with the process of business intelligence implementation to confirm and validate the criticality of the success factors synthesised from the literature review, including the critical success factors' relationship, by employing a five-point Likert scale. Descriptive statistics such as mean, frequencies and percentages were used to provide an initial demographic understanding of the survey data, while Chi-Square was used to test the association between the reported BI implementation successes and some of the characteristics of the participating organisations. Thereafter, factor analysis was used to explore the CSFs' variable relationships, and to establish their explicit impact on BI implementation success. The results were then used in a bivariate pair-wise correlation analysis to examine which set of critical factors relate to which BI success measure, and are most likely to influence the realisation of a particular BI success objective. The quantitative survey data analysis was aided by the use of a computerised statistical package, namely SPSS version 21.

The case study consisted of semi-structured interviews undertaken in four UK organisations that had implemented business intelligence systems, in order to understand the process, challenges and applicability of the critical success factors in real-life project situations. The four participating organisations were: the UK Office of Rail Regulation; Transport for London; Gap Incorporated (a major fashion retailer); and SAS (a major BI software provider). The study employed thematic content analysis on the qualitative case study data, aided by the computerised qualitative data analysis software, QUALRUS.

The last stage involved the triangulation of both of the survey and interview case studies in line with the research objective and existential literature in reaching the research conclusions and recommendations. This was followed by a proposed success model of business intelligence system implementation based on an integrated perspective that could guide practitioners in their BI initiatives.

8.3: Conclusions to Key Research Findings

This research has made key findings that enhance the understanding of the critical success factors (CSFs) that influence business intelligence system implementation in a number of ways. A detailed discussion can be found in Sections 7.3 and 7.4 of the last chapter.

Firstly, business intelligence implementation is of major relevance to both theory and practice given its top priority and reported failures. The study identified 14 critical success factors (CSFs) that must be carefully considered to ensure business intelligence implementation success. These were derived through a three-stage rigorous process that involved firstly, a literature synthesis and scoring of the most commonly reoccurring critical success factors from about thirty CSFs variables used in twenty-five similar information management studies. These were then validated in a survey for their relevance, criticality, factor reduction and interrelatedness, and finally, corroborated in a real-life case study setting for their applicability and challenges. The study's findings revealed a strong positive correlation between the derived CSF variables and business intelligence implementation success, with a statistical total variance explained of about 61% of BI project success. This suggests that the critical success factors derived from this study were statistically significant (Hair et al., 2009) and this gives confidence for their adoption for practical business purposes.

Second, the study found that the critical success factors that influence business intelligence system implementation are in a covariance of four major cluster dimensions. These are organisational related CSFs (clear business case and BI vision, management support and strong executive sponsor and team skills); process related CSFs (communication, project management, change management and user participation); technical related CSFs (ICT infrastructure, software selection, implementation methodology and data management and integration), and user related CSFs (training and user intuition). Consequently, the study suggested that the CSFs of BI implementation should be considered from the perspective of their interrelatedness and interdependence as identified in the factor clusters to maximise their input in the implementation process, rather than from a singular, independent and static perspective.

Third, given that organisations may have different emphases or preferences in their business intelligence implementation objectives, the study identified which sets of critical factors relate to which BI success attribute and are most likely to influence the realisation of a particular business intelligence success objective. For instance, the BI success attribute of *advanced predictive analysis* is found to be most correlated with the critical success factors of implementation methodology and technical infrastructure (see Appendix 15), which suggests a great influence and attention in the realisation of the BI system objective of *advanced predictive analysis.* Furthermore, the study's findings also identified empirically verified BI success attributes that an organisation could consider in order to make their implementation more acceptable and successful. The most important, in order of priority were: easy to use, better quality information, speed of system responsiveness, advanced data visualisation capability, real-time data, advanced predictive analysis and support for mobile BI devices.

Fourth, the study found that business intelligence system implementation is complex and difficult, and fraught with failure points along the project's life cycle. While the identified critical success factor variables used in this study may seem familiar from the perspective of information system research generally, the study found that they have their own contextual relevance, scale, complexity and challenges when it comes to applying them in business intelligence implementation, compared to conventional standalone information management systems. The interview case study for instance, found that there is a need for management support that cuts across business functions and departments as well as an executive sponsor with clout to galvanise resources for the project from across various departments affected by the BI initiative. There are also data management challenges due to the size (terabytes), variety, velocity and disparity of the data, with different ownership structures and coming from different data providing organisations. These include the extreme challenges of data transformation, integration and big data analytics, coupled with the exceptional technical infrastructural requirements. There are also the communication and enterprise large-scale project management challenges which can all be easily underestimated when seen from the perspective of conventional departmental information management system deployments, which is a recipe for BI project failure. The practical implication is that organisations recognise the conceptual relevance and challenges in the adoption of the CSF elements, to make BI implementation projects more successful.

Fifth, the study's findings indicate that organisations have different reasons for undertaking a BI implementation: it can be business-driven, technically-driven, or both. The most identifiable reasons in order of importance include: improved decision support; increased operational efficiency; better use of corporate data; increased business competiveness; identifying new business opportunities; consolidating reporting systems; and reducing IT operational costs. While some of the benefits are tangible, others are intangible and difficult to measure, and there were also anticipated benefits that were yet to be realised. What the findings suggest is that: (a) the BI system needs to be closely aligned to the company's strategic objective; and (b) where benefits are difficult to measure, BI should be articulated as enhancing the realisation of the more tangible benefits in order to justify the investment and support from top management.

Sixth, the study's findings indicate that although business intelligence system implementation is facilitated with technology, BI projects should be owned and driven by executives and senior managers from the business side, rather than by the IT department. Their strong and continuous commitment and aligning the BI strategy to the overall business vision are fundamental to the success of the implementation. That commitment should be amplified and visibly demonstrated at all levels of management to influence and galvanise resources and all participants for the success of the BI implementation project. This is particularly important in business intelligence systems implementation where the study found, for example, that data ownership still remains with source departments and data providing organisations.

Seventh, the study found that the new critical success factor variable of *user intuition*, included in the research conceptual framework for variable validation, was statistically supported by the study data. In fact, in the statistical analysis, the variable *user intuition* had the highest item factor loading, greater than user training within the user related CSF cluster, which is indicative of its greater importance. The study's findings suggest that users' intuitiveness, enthusiasm and ability to harness and exploit the BI system have a significant impact on the benefits derived from the system and the perception of BI success. The survey study, for instance, found extensive use of standard BI functionalities such as excel spreadsheets and basic reporting functions, while advanced functionalities such as predictive data analytics, which really make the difference in terms of BI benefits, were either fairly used, or not used at all, thus undermining the potential benefits of the implemented BI system. The interview case studies also corroborated the survey findings that even the implemented BI solutions were not being optimally utilised. This finding implies two things. Firstly, business intelligence solutions should be implemented with the end user in mind. Secondly, it should be realised that the benefit of a BI system is not whether it is used, but how it is used, and this can have a disproportionate impact on the benefits derived from the BI system and perceptions of it. This is because business intelligence systems, unlike conventional processing and information provider applications, are analytical systems that require elements of human thought and intuition, in order to use the same sets of data in different scenarios of "what if analysis", to generate new understanding and business knowledge (Howson, 2008; Isik, 2009). Thus, although technology can provide notifications, monitor events, automate responses, and provide data, the study's finding suggests human ingenuity and intuition is crucial to turning that data into information and knowledge for efficient decision-making processes.

Eighth, information system (IS) outsourcing is topical and beyond the scope of this research. However the study sought to find if a pattern exits between BI implementation success and some of the characteristics of organisations and approach to BI implementation. This study found no statistically significant evidence of an association between reported BI implementation success or failure, and the approach to implementation with regard to whether it was outsourced, undertaken by an in-house team or a combination of both. Furthermore, the study did not find any statistically significant association between BI implementation success or failure, and industry types (retail\wholesale, financial, manufacturing, private, public or service). The four interview case studies did not indicate any clear pattern with respect to reported BI success or failure and organisational type either. All of this suggests that BI systems are relevant to all business types, and implementation success is not related to any industry sector or whether or not the implementation is outsourced. It also reinforces the point that other related critical success factors exist; their combined effect influences BI project success, rather than any singular factor.

Ninth, the study's findings indicate that BI systems are no longer viewed as tools that are used exclusively to support strategic decision-making by top management as in the early days. The interview case study found that organisations have begun to further exploit the capabilities of BI systems to support wider front-end business activities in tactical and operational process improvements. These new developments have allowed line managers to access relevant and timely information and make better and instantaneous decisions. The experiences of business intelligence system implementation and the benefits reported in this study demonstrate the current move to deploy BI systems at the operational level to support a broad range of operational activities along the business value chain.

Finally, the study proposed an integrated success model of BI project implementation to guide the process (see Figure 7.1). The model posits that BI initiatives should start by determining the relevant drivers - "the "must have" success measures" - and managing the corresponding critical factor antecedents. Practically, the model highlights core critical factors and their interrelationships, which implementers should focus on to make their deployment more successful. The dominant critical success factors by item scale based on their interrelationships in the clusters were found to be technical infrastructure, communication, management support, and user intuition. The proposed integrated model represents best practice for success and is based on the experiences found in the empirically validated results.

8.4: Research Contributions

This study advances the theory and practice of business intelligence in a number of ways.

8.4.1: Theoretical Contribution

First, the field of business intelligence as an academic discipline is new (Chen et al. 2012), and indeed the theory of critical success factors with respect to business intelligence implementation is still evolving. While existing studies have sought to identify, name and examine how the critical factors are undertaken in inductive case studies (Yeoh & Koronios, 2010; Olszak & Ziemba, 2012; Chen et al., 2012; Olszak 2014), this study extends the existing knowledge by empirically assessing the underlying interrelationship and interdependence between the critical success factors (CSFs). This study also sought to establish, unambiguously, the explicit impact of the CSFs on business intelligence implementation success. From a theoretical perspective and with regard to its originality, it extends the current research and provides a new understanding and framework in which future research examining the relationship between critical success factors (CSFs) on the one hand, and CSFs and BI success on the other, could be conducted.

Secondly, the proposed research model conceptualises an optimal strategy of BI implementation that targets critical success factors related to the BI success measures. Existing studies have either investigated the critical success factors or the success measures but not both. Hwang and Xu (2007) stressed that future research on the critical success factors of information management systems should include both sets of variables in their investigation. This study sought to address this research gap and it might perhaps be the first to examine both sets of variable relationships in one model within business intelligence research. From a theoretical perspective, such an integrated approach provides a new understanding of CSF studies, in particular with regard to business intelligence systems implementation.

Third, the research has introduced a new critical success factor "User Intuition", to be validated in the research conceptual framework which has not been used or tested before in any previous studies (Yeoh, 2010; Olszak & Ziemba, 2012; Dawson & Van Belle, 2013). The survey result found this new variable to be a statistically significant critical success factor. The case study findings corroborated the survey findings. For instance, one of the interview participants indicated his disappointment with regard to the fact that their implemented BI solution is not being optimally utilised, such that, according to him, they are having to use a "carrot and stick" approach in order to get the staff to take advantage of the new functionality offered by the BI system. Both findings shed new light on the need to harness the BI system and optimise its use. As noted by John Naisbitt (2008), a former executive of IBM and later Kodak 2008, in his work, Megatrends and Re-inventing the Corporation, "*intuition becomes increasingly valuable in the new information society precisely because there is so much data*". Indeed this study tested this proposition and found it to be significant and it provides a new understanding on this critical success factor. Practically, it suggests approaches to increase the usage and optimisation of the BI system either through training, motivation and reward systems, the development of BI competency teams or advocates within the organisation; this is discussed in Section 7.3.4. Theoretically, it offers an avenue for further research and validation of this factor, to increase the overall body of knowledge on business intelligence systems implementation.

Fourth, methodologically, this study adopted a realist, pragmatist research paradigm, employing a mixed methods approach to its investigation, which is not often used in information systems research. Existing studies on the critical success factors of business intelligence have been mostly qualitative, inductive case studies (see Section 4.6). The triangulation of mixed methods demonstrated in this study provides another perspective on how future investigations into the CSFs of BI implementation could be conducted. Kaplan et al. (1988) noted that triangulation "increases validity" that comes using different methods. The nature of business research is such that the outcomes provide value through their practical application in organisational settings. The realist approach adopted in thus study provides that perspective and facilitates practicality, while still maintaining the transient underlying theoretical nature of the research (Bryman & Bell, 2006). While the quantitative study provides concrete, measurable information on the study's constructs, the qualitative study provides a deeper understanding of how the process and research variables are enacted in real-life settings, thereby complementing the former and strengthening the research outcome.

8.4.2: Contribution to Business Practice

Firstly, business intelligence implementation is in the top ten IT deployments in excess of $17 billion dollars year spending (Gartner Research 2013) because of its potential. Given the reported failures, the need to investigate BI and find solutions cannot be overemphasised. This study applied the theory of critical success factors to the contemporary practical problem of business intelligence system implementation. The findings, recommendation and proposed model, based on empirically validated results and experiences will provide guidance to organisations implementing or intending to implement a business intelligence system.

Secondly, the model proposed in this study (see Section 7.4) grouped the derived CSFs of BI implementation into four major cluster dimensions, based on their underlying covariance and interrelationship using exploratory factor analysis (EFA). This advanced statistical technique helps to identify meaningful distinct groups of elements that exhibit similar characteristics and hence similar implications for business practices. Consequently, by understanding the CSFs' interrelationships and how they cluster, one can understand: (a) which CSFs can work better together, (b) CSFs' interdependence and management of risk, and (c) which CSF influences, either negatively or positively, the output of the others.

Third, the nature of critical success factor (CSF) research is such that existing studies have used different CSFs, often depending on the researcher's perspective. While this is understandable, however, the research findings are fragmented and isolated and it is difficult to identify a common set of CSFs that the industry can rely. This study has identified, synthesised and harmonised the most re-occurring CSFs used in various studies into a common set of critical factors for practical purposes and professional best practice. Furthermore, the resulting proposed model not only synthesises the most critical success factor variables of BI implementation, but also highlights core variables within a group of related CSFs that implementers can focus on in order to make their implementation more successful. From a practical project management perspective, such a harmonised set of CSFs can provide guidance to organisations intending to implement or currently implementing BI systems when faced with the problem of identifying the relevant CSFs and how best to allocate scarce resources, minimise risks and monitor the implementation process.

Fourth, the study's proposed success model assessed the relative importance of the critical success factors, but from a different perspective. While existing CSF ranking-types have adopted statistical means scores from singular item dimension (Dawson & Van Belle, 2013; Naderinejad et al., 2014), this study adopted a multi-dimensional approach employing exploratory factor analysis (EFA), which is based on the sum of each CSF's inter-item multiple correlation with the others. Thus, for example, while finance was found to be important in this study as a single variable, its inter-item correlation with other variables was found to be weak (see section 7.3.5). From a practical business perspective, this suggests that although finance is important as a CSF variable, increasing finance, for instance to pay for more expensive IT equipment or more expensive consultants, might not necessarily lead to a corresponding increase in the output of other CSFs in the BI project. This might seem obvious, but the results of this study from empirically validated data give credence to such an assumption which is the essence of research for business practice. Furthermore, the research findings not only highlight CSFs interdependence, but also identify which sets of CSF relates most to which BI success objective. From professional management perspective, all of these provide practical guidance to BI implementers on which CSFs to target and focus on, to make their BI implementation objective more realizable.

Fifth, BI professionals and consultants can benefit directly by using this study's findings, suggestions and proposed model to support better and practical decision-making actions across the various stages of the BI project life cycle from pre-implementation, to the implementation and post-implementation stages, including managing and monitoring. This can be done for instance by creating awareness of the relative importance of individual factors or by identifying groups of interdependent critical factors and addressing them as common measures. Furthermore, it could also provide a baseline for prioritising the exact set of CSFs that need attention in order to realise a particular BI success objective. Appendix 15 provides a handy reference in this regard. Also, for organisations looking for BI success qualities to adopt, the study's findings offer a reference that can be considered in order to make their BI implementation more acceptable and successful.

Sixth, the study's proposed model provides an insight into the components of BI project implementation based on an integrated perspective (see section 7.4.1), grounded on a robust theoretical background and the experiences of leading organisations in their industry. The comprehensive approach adopted in the study offers a well-rounded holistic picture of BI implementation and is more relevant to the practical challenges of BI implementation than a much narrower, singular independent perspective, which in most cases leads to implementation failure (Hawking & Sellitto, 2011). The proposed model could enable organisations to translate their BI business requirements into a set of critical success factor antecedents. Furthermore, the model is dynamic and flexible and can accommodate changing business needs and corresponding CSF requirements. Thus, from a project management perspective, the study's findings and proposed model provide prescriptive guidelines to organisations intending to implement or currently implementing BI systems, when faced with the problem of identifying CSF resources, and how best to allocate scarce resources, assign risks and manage the implementation process.

Finally, the accounts and experiences of the leading organisations that participated in the case study such as: Transport for London (TFL), The UK Office of Rail Regulation (ORR), Gap (a major fashion Retailer), and SAS (a leading BI Software vendor) will provide rich experiences and best practice for others wishing to undertake or presently undertaking such a venture. For instance, the implementation of a business intelligence system to manage and monitor London traffic during the 2012 Olympics is insightful and enlightening and would be of benefit to organisations contemplating a business intelligence initiative.

8.6: Limitations of the Study

As with most research of this nature, this study was subject to the limitations of time, access to information, scope, generalisability and even the research techniques themselves.

Although this study reviewed a large body of relevant literature and collected a large amount of data from both interviews and surveys, it is not possible to claim that the study had identified every issue related to BI project implementation. Business intelligence literature is relatively new and developing with growing interest. There might be newer literature that may not have been captured especially after major data analysis and final write-up had started. However, this is not uncommon with large-scale research of this nature, and it has not affected the core findings of the study.

Also, the study adopted a mixed methods approach that triangulated a quantitative study with a qualitative study. Although the quantitative survey study (N=102) was strengthened by the qualitative interview case studies of four organisations that had implemented business intelligence systems, supported with available organisational documents, the qualitative case study was not without limitations. The major limitation was the number of interview participants. While efforts were made to interview as many people as possible in each organisation, unfortunately the companies were reluctant to provide access and only allowed one interview participant due to a lack of time and staff engagements. With more participants per investigation, perhaps more rich data could have been obtained. However, the participants interviewed were major stakeholders in their organisations based on their role, such as Business Intelligence Managers and Principal Developers. They were knowledgeable about the BI projects and had played a key role from the beginning to the end of the BI project in their organisation.

Furthermore, the research adopted standard techniques of data collection and pre-testing interview questions and questionnaire. However there was no practical way to assess the sincerity of respondents when completing the survey questionnaire or giving direct answers during the case study interviews. The study is based on the assumption that the research participants responded honestly to the questions asked and that their views accurately describe their experiences of business intelligence implementation in their organisation. It is possible especially with regard to the survey, that the respondents might have understood a questions differently from the way in which the researcher intended it to be answered. However, it must be said that these are standard limitations of research methods, and the study did take appropriate steps to limit their impact, in order to ensure its reliability and validity. These included wording the questions appropriately, cross-checking questions with the interviewees, using organisational documents, pre-testing the questionnaires, sending out the questionnaires and interview questions with an introductory research brief, tape recording the interviews, and using computerised data analysis techniques for both the quantitative and qualitative data, in order to minimise human error. All of these were discussed in section 4.5 of the methodology and research design chapter.

It should be mentioned that about 86% of the survey respondents considered themselves to be working for a UK organisation and the four interview case studies were conducted with UK companies. However, this sample is not representative of the full range of organisations that had implemented and make use of business intelligence systems. The geographical location focus was necessary to keep the study within manageable levels of scope, cost and access, including limiting the potential of moderating variables arising due to differences in geographical cultures. Therefore, the outcomes of this research may not be immediately applicable to other countries without some form of adaptation.

Moreover, the majority of the study's respondents could be considered as working in very large organisations that have yearly revenues in excess of 50 million dollars and which have implemented major BI software platforms that account for about 60% of the market share, such as Microsoft, SAP, IBM, Oracle and SAS platforms (Gartner Research April, 2014). Therefore, there might be respondent bias with this group of participants towards these major BI software platforms, which may not have been captured in the investigation. Perhaps studies with smaller companies that have implemented less popular BI software platforms may produce different results. Furthermore, most of the survey respondents could be considered to be senior and middle line managers based on their roles. While they were in a good position to evaluate the importance of various implementation factors, their perceptions on the success of the delivered systems are probably not without bias. Although it should be stated that the study undertook tests of association between the views expressed by participants in different roles with respect to BI implementation success, and this was found to be statistically insignificant. Perhaps, a larger sample size might indicate otherwise.

Finally, this study has taken an enterprise end-to-end perspective of business intelligence system implementation. It is possible that organisations might only be interested in implementing one or two functional components of a business intelligence system, for example BI reporting, BI dashboards, BI scorecards and BI analytics. Research into some of these individual BI functional components could provide useful insights and a greater understanding of the broader field of business intelligence implementation.

8.7: Directions for Further Research

This study had addressed important questions with respect to the phenomenon of BI implementation and made contributions as discussed. However, it also raises some questions and offer scope for future research.

Firstly, this study is probably the first of its kind within the area of the CSFs of business intelligence to include the CSFs and the BI success measures in one model in order to test their interrelationship and interdependence, and as such, the model that emerged is still in a formative stage. Future work could be done to validate and refine the relationships and impacts embodied in the proposed model to increase its explanatory power. It would be possible, for example, to add or remove a CSF variable, collect data and then test and revalidate the model to see whether this improves it. It would also be possible to undertake further confirmatory factor analyses such as structural equation modelling with the results of this study to further examine or postulate a new inter-item relativity. There are different streams of research possibilities that could arise from the study's findings and proposed model. This would also increase its generalisability.

Secondly, this research is based on the premise that BI systems are different from other information management systems due to their core analytical business objective and complex architecture and components as distinguished in Section 2.8, and thus there are specific critical success factors that are relevant to their implementation. It is possible that similar relationships espoused in this study could be applicable to other forms of information management system implementation. Thus the same or different CSF variables and success attributes could be employed or combined, to test the interdependence of the critical factors and the applicability of the model to other information management systems.

Thirdly, the case studies were based on the UK railway and commerce industries and the survey respondents were from UK organisations. Furthermore, the sample size, location and characteristics of the respondents are not representative of the full range of organisations that have implemented and made use of business intelligence systems. These results may therefore not be representative of the relationships that may exist in other countries or organisations. Future research could be conducted in other countries to assess the relationships between the critical success factors embodied in this research to further test its reliability and transferability.

Fourth, the study sought to examine whether any relationship exists between the reported business intelligence system implementation success or failure and the particular industry, or the approach to BI implementation, for instance whether it was outsourced, undertaken by an in-house team or a combination of both. This study did not find any significant statistical association in these respects. However, these findings do provide avenues for further research investigation and validation, for instance on BI outsourcing, which could strengthen this study's outcome and provide an interesting insight for both academia and business practice.

Fifth, an interesting finding that emerged from this research is the lack of consensus regarding what constitutes information system success and business intelligence system success in particular. This study sought to operationalise the concept of business intelligence implementation success using attributes and proxies from the existing literature on information management systems. However, "success" is a contentious and a multi-faceted concept in information management systems (IMS) research and the BI success measures adopted in this study may not be universally applicable in all BI projects. Future empirical research into the measurement of business intelligence success would enrich the understanding of how BI can impact on organisational effectiveness.

8.8: Conclusion.

Business intelligence is an important and emerging area of information management systems for both researchers and practitioners. However, few rigorous empirical studies have been conducted on business intelligence practice in general, and the critical success factors of BI system implementation in particular. Another issue is that the existing research has used different critical success factor variables, often depending on the researcher's perspective, and the findings are fragmented, thus making the comparison and integration of different studies difficult. This study sought to explore the critical success factors of business intelligence system implementation. Specifically, it examined the relationship between the synthesised critical success factor variables, their degree of criticality and the extent to which they explain business intelligence implementation success. It also examined which critical factor is related to which BI success measure.

The study employed a three-stage research approach that involved: a systematic literature review followed by the development of the research theoretical framework; a survey on major stakeholders to confirm some of the research constructs; and an interview case study to better understand the BI implementation phenomenon in real-life settings to complement the survey findings.

The results of the study indicate that BI system implementation success hinges upon a set of four major interrelated and interdependent critical factor cluster dimensions. The study also found that the critical success factor constructs have their own contextual complexity and challenges when it comes to BI implementation, which is different from conventional information management systems.

This study leverages the theory of critical success factors with a contemporary practical problem of business intelligence system implementation. Firstly, it enriches the theoretical understanding of the phenomena with real-life experiences. Secondly, it is of practical benefit to organisations that are faced with the challenge of how to manage the critical success factors and align them to their BI success objectives. Of course there are limitations, which also offer opportunities for further research.

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APPENDICES

Appendix 1: IS-World's top 50 ranked MIS journals and electronic availability

Ranked MIS Journals		Literature Vendor (Database)											
No.	Journal Name	ProQuest (ABI/INFORM)	Elsevier (Science Direct)	INFORMS	IEEE (Comp Soc&Xplore)	Wilson (OmniFile)	Thomson (G. Bus, OneFile)	ACM (Digital Lib)	JSTOR	Blackwell (Synergy)	LEA Journals	EBSCO host	Free Full Text Web Access
1	MIS Quarterly	x		x		x	x		x				
2	Information Systems Research	x		x			x					x	
3	Communications of the ACM	x					x	x					
4	Management Science	x		x			x		x			x	
5	Journal of MIS	x				x							
6	Artificial Intelligence		x										
7	Decision Sciences	x									x		
8	Harvard Business Review	x					x						
9	IEEE Transactions (various)				x			x					
10	AI Magazine	x				x	x						
11	European Journal of IS	x											
12	Decision Support Systems		x										
13	IEEE Software				x								x
14	Information & Management		x										
15	ACM Transactions on DB Systems						x	x					
16	IEEE Trans on Software Eng				x								
17	ACM Transactions (various)	x					x	x					
18	Journal of Computer and System Science		x										
19	Sloan Management Review	x				x	x						
20	Communications of the AIS							x				x	
21	IEEE Trans on Sys, Man, &Cyb				x								
22	ACM Computing Surveys	x					x	x					

23	Journal on Computing	x					x					x	
24	Academy of Management Journal	x					x		x				
25	International Journal of Electronic Commerce					x							
26	Journal of the AIS							x					
27	IEEE Transactions on Computers				x								
28	Information Systems Frontiers	x											
29	Journal of Management Systems	x				x							
30	Organization Science	x		x			x		x			x	
31	IEEE Computer				x								
32	Information Systems Journal									x			
33	Administrative Science Quarterly	x				x	x		x				
34	Journal of Global Info Management	x					x						
35	The DB for Advances in IS	x											
36	Journal of Database Management	x					x						
37	Information Systems		x										
38	Academy of Management Review	x					x		x				
39	Journal of the ACM	x					x	x					
40	Computers & Operations Research		x										
41	Human-Computer Interaction											x	
42	California Management Review	x											
43	Information Technology & People	x											
44	Journal of Strategic IS		x										
45	Journal of Global IT Management	x											
46	ACM Transactions on IS						x	x					
47	Informing Science											x	x
48	Journal of Information Management	x											
49	Operations Research	x					x		x			x	
50	Journal of Computer IS	x											

Appendix 2: Ranked and Non-Ranked IS Conferences Electronic Availability Proceedings.

No.	Ranked and Non-Ranked IS Conferences Ranked Order is Based on Hardgrave and Walstorm (1997) Name of Conferences	Literature Vendor (Database)				Full Text Web Access (Fee)	Full Text Web Access (Free)	Proc. CD-ROM for purchase
		Elsevier (Science Direct)	INFORMS	IEEE (Comp Soc&Xplore)	ACM (Digital Lib)			
1	International Conference on Information Systems (ICIS)				x			
2	Hawaii International Conference on System Sciences (HICSS)			x			x	
3	International Federation for Information Processing (IFIP)				x	x		x
4	International Conference on Decision Support Systems (DSS)				x			
5	Decision Sciences Institute (DSI) - National Conference					x		
6	Society of Information Management (SIM) Conference	x						
7	International Association for Computer Information Systems (IACIS) Conference(Proceedings published in Issues in Information Systems)					x		x
8	Institute for Operations Research and the Management Sciences (INFORMS) Conference		x					
9	Information Ressources Management Association (IRMA) Conférence							x
10	Academy of Management (AOM) Conference					x		
11	Decision Sciences Institute (DSI) - Regional Conferences					x		x
NR	International Academy of Information Management (IAIM) Conference					x		x
NR	American Conference on Information Systems (AMCIS)				x			
NR	Information Systems Education Conference (ISECON)						x	x
NR	Institute of Electrical and Electronics Engineers (IEEE) National Conferences			x				
NR	Informing Science + Information Technology Education (InSITE) Conference						x	x

No. - Indicates the rank of a conference in general by Hardgrave and Walstorm (1997)'s study

NR - Non-ranked.

Referenced from (Levy, Y. & Ellis, T.J, 2006)

Appendix 3: Copy of Study Introductory Letter

KINGSTON UNIVERSITY

Business School
Kingston Hill, Kingston upon Thames, Kingston Surrey KT2 7LB, United Kingdom.
Tel: 020 8417 9000

Interview Theme: Critical Success Factors of Business Intelligence Implementation

Dear Sir,

Business Intelligence Implementation
As you may appreciate, business intelligence system is one of the topmost IT spending at the moment. Organisations are immersing themselves in its implementation to take advantage of the huge potential of their silos of data. However, BI implementations have not been without some failures or dissatisfaction, which raises a lot of question.

The research seeks an understanding of the process and critical success factors of business intelligence implementation, and major impediments to success.

Your presentation at the recently concluded Data Warehouse and Business Intelligence conference in London 5th-7th November, 2012 was really very interesting, and your expertise and experience with such system would be great value to our research and would be highly appreciated

The interview would take no more than an hour, and could be spread in two sessions at your convenience. It would basically be on;

- A brief background on the organisation business intelligence implementation,
- Some critical success factors from your experience,
- Lessons learned and complications encountered
- What you would recommend to others contemplating such initiative, and
- How organisations could maximize the potential benefit of BI initiatives.

As an appreciation of your participation, you would be sent a link to download the executive summary of the final study findings.

It should be stressed that the research is strictly an academic exercise and participants are guaranteed anonymous and confidentiality.

Thanks for your time and corporation.

Regards and thanks
Samuel Egbeniyoko
Key Researcher
cc.
Dr. Richard Van Den Berg
Dr. Serhiy Kovela
Research Supervisory Team (Senior Lecturers Kingston University Business School).

Appendix 4: Copy of Interview Letter of Consent

KINGSTON UNIVERSITY

Business School
Kingston Hill, Kingston upon Thames, Kingston Surrey KT2 7LB,United Kingdom.
Tel: 020 8417 9000

Interview Theme: **Critical Success Factors of Business Intelligence Implementation**

Interview Consent Form

Researchers Name: Samuel Egbeniyoko

Research Supervisory Team:
Dr. Richard Van Den Berg
Dr.Serhiy Kovela

- I confirm that I am more than 18 years of age.
- I have been briefed on the research and understand the purpose of the research
- It had been made clear to me that the research is strictly an academic exercise and participants are guaranteed anonymous and confidentiality
- I understand that I may withdraw from the interview at any stage and this will not affect my status now or in the future.
- I understand that audiotape would be used during the interview.
- I understand that the tape will be locked safe and its content would only be accessible by The researcher and the supervisory team for the purpose of this research only.
- I understand and agree to take part in the interview

Thanks for your time and corporation.

Name of Participant:
Signed **Date:**

I confirm that I have provided information about the research to the research participant, and that its purpose is only for research use at the Kingston University Business School, Kingston U.K.

Name of Researcher: Samuel Egbeniyoko
Signed **Date:**

Appendix 5: Copy of Survey Questionnaire

Survey brief.

The questionnaire should take no more than ten minutes to complete. It is academic and all responses are guaranteed anonymity and confidentiality.

Thanks for your corporation

1. **Where is your organization located?**

- ☐ Asia
- ☐ South America
- ☐ USA & Canada
- ☐ United Kingdom
- ☐ Rest of Europe
- ☐ Africa & Middle East

2. **What is the primary business activity of your organisations**

- ☐ Manufacturing
- ☐ Professional Services (Law, Consultancy others.)
- ☐ Retailing & wholesaling
- ☐ Public\Education\Non-profit organization
- ☐ Financial services (Banking, Insurance, others)
- ☐ Engineering\Construction & Mining
- ☐ Transport & Logistics
- ☐ Leisure/Catering/Hotels
- ☐ Telecommunications & IT
- ☐ Others specify

3. **Annual revenue**

Under$ 10 million	$11 million- $50 million	$51 million - $100	$101 million and above
☐	☐	☐	☐

4. How would you describe your role in your organization

CEO\CIO\Executives ☐

Business intelligence manager\project managers\line managers ☐

IT Professional (consultant, system architect, DBA\developers etc.) ☐

Business intelligence system analysts\user ☐

Others, please specify

5. How long have you worked with business intelligence systems

Under 5 years	5 - 10 years	More than 10 years
☐	☐	☐

6. What were some of the motivations for implementing business intelligence in your organisation? Please check all that apply

- ☐ Desire to identify new business opportunities
- ☐ Desire to increase business competitiveness
- ☐ Support better business decisions
- ☐ Improve better use of corporate data
- ☐ Identifying profitable areas of operations
- ☐ Achieve business process change
- ☐ Provide better customer service
- ☐ Increased operational efficiency
- ☐ Reduce operations & IT cost
- ☐ Others, please state

7. What technology or software was used in your business intelligence implementation? (e. g., SAP, Oracle, etc.)

- Microsoft BI suit
- Oracle BI suit
- SAP BI suit
- IBM BI suit
- SAS BI suit
- MicroStrategy
- Mixed and match of software
- Custom developed
- Others, please specify

8. How long did your business intelligence implementation take?

Under 1 year	1.1 - 3 years	3.1 - 5 years	more than 5 years
☐	☐	☐	☐

9. Which of these BI features were implemented in your organization. Please check all that apply

- Data warehouse repository
- Standard reports and analysis function
- Dashboard
- Mobile BI and support for mobile devices
- Enterprise search capability (fuzzy look-ups, word streaming)
- Advanced predictive analytics and mining
- Score cards\KPIs
- Others, please specify

10. Below are some critical success factors of business intelligence implementation. Please rank their importance on a scale (Ranking: 5 = Highest; 1 = Lowest)

	(5)Very important	(4) Important	(3) Neutral	(2)Not important	(1) Not very important
Clear business case and vision.	☐	☐	☐	☐	☐
Top management support	☐	☐	☐	☐	☐
Executive Sponsorship	☐	☐	☐	☐	☐
Adequate resources and budget	☐	☐	☐	☐	☐
Nature of organization	☐	☐	☐	☐	☐
Communication with stakeholders	☐	☐	☐	☐	☐

	(5)Very important	(4) Important	(3) Neutral	(2)Not important	(1) Not very important
Project planning and management	☐	☐	☐	☐	☐
Managing change and expectation	☐	☐	☐	☐	☐
Software selection & vendor support	☐	☐	☐	☐	☐
Technical infrastructure	☐	☐	☐	☐	☐
Data quality & integration	☐	☐	☐	☐	☐
Implementation methodology (Prototyping & Piloting)	☐	☐	☐	☐	☐

	(5)Very important	(4) Important	(3) Neutral	(2)Not important	(1) Not very important
Appropriate team skills	☐	☐	☐	☐	☐
User participation	☐	☐	☐	☐	☐
User training	☐	☐	☐	☐	☐
User competencies and intuition	☐	☐	☐	☐	☐

11. How important are the following qualities to your perception of business intelligence system. Please rank (5 = highest; 1 = lowest)

	(5) Very important	(4) Important	(3) Neutral	(2) Not important	(I) Not very important
Easy to use, adaptable and flexible		☐	☐	☐	☐
Better quality information	☐	☐	☐	☐	☐
Speedy information retrieval	☐	☐	☐	☐	☒
Support for Mobile BI, devices, cloud	☐	☐	☐	☐	☐
Advanced data	☐	☐	☐	☐	☐

visualisation, score card, dash board, KPIs etc.					
Integrate with enterprise applications such as ERP CRM, etc.	☐	☐	☐	☐	☐
Real time data analysis.	☐	☐	☐	☐	☐
Advanced predictive\statistical analytics	☐	☐	☐	☐	☐

12. To what extent are the following business intelligence technologies used to share insight in your organisation business activities

	Used extensively	Limited use	Not used
Spreadsheet/Microsoft excel	☐	☐	☐
Standard Reports HTML, PDF	☐	☐	☐
Dashboard (drillable/interactive data-visualisation interface)	☐	☐	☐
Score cards, Key performance indicators KPIs.	☐	☐	☐
	☐	☐	☐

Alerts\exception thresholds (email, SMS, etc.)			
Mobile (smart phone, tablets)	☐	☐	☐
Advanced predictive analytics & statistical simulations	☐	☐	☐

13. The following could be considered as barriers to enterprise BI analytics adoption. Please rank response (5 = highest, 1 = lowest)

	(5) Strongly agree	**(4) Agree**	**(3) Neutral**	**(2) Disagree**	**(1) Strongly disagree**
Data quality problems	☐	☐	☐	☐	☐
Ease of use challenges with less technical staffs	☐	☐	☐	☐	☐
Integration and compatibility issues with existing multiple platforms	☐	☐	☐	☐	☐
Challenges of scaling the technology across the entire organization	☐	☐	☐	☐	☐
Challenges of getting constituents to agree on BI standards	☐	☐	☐	☐	☐

Software licenses too expensive	☐	☐	☐	☐	☐
No clear return on investment ROI	☐	☐	☐	☐	☐
BI Analytics talents is too expensive	☐	☐	☐	☐	☐
Staff training too time consuming and expansive	☐	☐	☐	☐	☐
Overlap with other systems	☐	☐	☐	☐	☐
Communication and getting major stake holders interested	☐	☐	☐	☐	☐
Others, please specify		☐	☐	☐	☐

14. In your estimation, how would you rate the overall success of your business intelligence project

0 - 20%	21 - 40%	41 - 60%	61 - 80%	81-100%
☐	☐	☐	☐	☐

15. Was your business intelligence system implementation outsourced to a third party company or it was implemented by in-house team

☐ Outsourced to a third party or specialist IT company

☐ Combination of both

☐ Implemented by in-house team

Please add any further comments here

Thanks for your cooperation

If you would like a copy of the study results, please complete the details sheet below.

Email:

Appendix 6: Copy of Interview Questions

Interview Theme: Critical Success Factors of Business Intelligence Implementation.

Background information

▶ Nature of the organization\business?

▶ Some background on the business intelligence implementation,
- Why was it implemented?
- Which systems did it replace if any?

▶ What was the BI strategy; what was it set out to archive e.g.
- to improve efficiency, business process- qualitative
- to reduces cost, increase sales and profitability-quantitative
- Others

▶ Which business unit or department uses it, and how do they use it.

Process of Business Intelligence initiative

▶ How was the process of business intelligence implementation, for example what actions and task were undertaken, what was done?
- Before the BI initiative
  (E.g. feasibility, project planning, prototyping, product selection,
- During the implementation process.
  (E.g. functional analysis, data analysis, design\customization, testing,
- After the implementation phase. (e.g. Going-Live, Support, training)

▶ How long did the BI implementation take, was it a big bang approach, or phased over time?

▶ What components and functionality were implemented e.g.
- Data Warehouse, ▫ Analytical & data mining function, ▫ Reporting function,
- Score\Dashboards, ▫ KPIs, ▫ Mobile\Web enabled BI

▶ What software and technology platform that make up the BI solution e.g. Microsoft, IBM, SAP, Oracle, MicroStrategyetc? What informed the choice of your software selection and why?

▶ From your experience, what were some the major challenges encountered during the BI initiative?

▶ How did you handle some of these challenges mention?

The Success of BI initiative

▶ What were the expectations from the business intelligence system, or what would make a successful BI system in your opinion?

▶ What were some key benefits that you have achieved from the BI implementation?

▶ Would the presence or absent of these factors contribute to your perception of BI success and why?

- Data Quality: Complete and Reliable data
- System quality; (fast, efficient, user friendly)
- Easy to Use
- System integration
- Others

▶ Where these success qualities something the organisation had control and how were they monitored during the implementation process?

Examining Critical Factors of BI Implementation

A number of factors had been identified as critical to the success of a business intelligence implementation; can we briefly explore the relevance of some of these factors?

Business Related Factors

▶ BI implementation involves an enormous amount of resources, was there a clear business case for the BI initiative, how was it done? Was a cost\benefit analysis undertaken and how?

▶ Who drove the BI initiative, was it business driven or IT driven and why?

▶ An executive sponsorship who carries the BI vision and strategy is said to be critical was there an executive sponsor for the BI project, how was his\her engaged?

▶ Did you had top management support for the BI project, and in what way e.g. briefings?

▶ Adequate budget surely is crucial for any project, did you had problems with funding e.g. project over run, or overspend? How did you convince the executives to continue to provide appropriate budget for the project?

▶ In your opinion, how relevant are these factors; (business case, executive sponsor, budget, management support) to the success of the BI project?

▶ Which of the factors above was not considered, and or undertaken in your BI project and why?

Process Related Factors.

▶ How was project progress communicated to all participants and how often e.g. via e.g. emails, bill boards, conferences, meetings etc.? In your experience, which was most effective and why?

▶ Project management, how was it undertaken in the project, was there specific project manager, project board, project governance, if not why not?

▶ Do you follow a specific project implementation methodology e.g. PRINCE2, PSM, etc., to guide the project, how was it adopted?

▶ Business intelligence implementation is likely to cause changes in existing business processes, structure, and the way people work, how did the organisation manage change and resistance?

▶ In your opinion, how relevant are these factors; (communication, project management, change management, methodology), to the success of the BI project?

▶ Which of the factors above was not considered or undertaken in your BI project and why?

Technical Factors

▶ An effective ICT infrastructure is considered critical to BI success, how adequate was the IT infrastructure, could you provide some details, was there any infrastructure refresh?

▶ BI implementation involves the integrating data from difference sources or systems e.g. CRM systems, Enterprise Resource Planning System ERP, Knowledge Management Systems etc. to produce a holistic, multi-dimensional view of data. How was data integration archived?

▶ What were some major difficulties encountered in integrating data and how were they managed?

▶ How was the team skills, did the organisation had to use external consultant in the BI initiative and why?

▶ How relevant in your opinion are these factors discussed (IT infrastructure, data integration and team skills), to the success of the BI project and why?

▶ Which of these factors was not considered and or undertaken in your BI project and why?

User Related Factors

▶ User involvement in initial BI project design and planning is said to be a critical factor, how was this applied this in this project?

▶ Was the technology or software used for supporting BI activities user-friendly and according to users' needs? P lease give details.

▶ What about user training, how was this done and at what stage? Is there any on-going learning environment?

▶ Business Intelligence systems unlike most other IT systems, requires user intuitiveness to get the best out of the BI solution, do you agree? How is this archived? Where there incentives to motivate employees towards best BI practices?

▶ How important in your opinion are these factors; user involvement, user training, user competency and intuitiveness important to the project success, and why?

▶ Which of these factors was not considered and or undertaken in your BI project, and why?

Final thoughts and Suggestions

▶ Is there any other important factor that you may want to briefly discuss?

▶ What are the lessons learnt from the BI project generally, in terms of success and failures?

▶ Any final comments and or suggestion for those contemplating a BI institutive?

Thank you for your co-operation

If you would like a copy of the study results report, please complete the following details;
Name:
Organization
Address
E-mail

Appendix 7: Sample Lessons Learnt Report

Office of Railway Regulator data portal – lessons learnt

What went well

Lesson learnt	Recommendation
The Club provided excellent support and governance	Would explore / recommend procurement via The Club as a first option
Introduction of local senior project manager and other resources turned the project around	Ensure appropriate resource is allocated from the start, and raise resourcing concerns early
Portal went live as scheduled, on time and to budget	Regular checkpoint meetings and efficient project management tools / processes are essential
Collaborative work [between Steria, ORR, IMG and SCC] ensured ORRbit was successfully integrated with the portal	ORR should continue to facilitate communication between third party suppliers
ORR's project board provided excellent governance and cross-directorate knowledge / experience	Ensure appropriate representation on the board and be clear what you want from them
'Gate' process ensured all parties knew what was required to progress the project / get paid	ORR should have more input into the process
Usability testing provided invaluable feedback and insight	Carry out widespread usability testing for projects of this nature
Phased launch worked very well	Provide ample opportunity for internal testing, by phasing the launch of systems

What went less well

Lesson learnt	Recommendation
End-to-end process not considered early enough.	Need the entire process documented (at least in draft) at a much earlier stage
Expectations raised too high during the UI workshops	Designers / programmers need to attend UI workshops. Or each workshop needs documenting and discussing with designers / programmers immediately
Statement of Requirements (SoR) not followed as the scope of works	SoR should be referenced at each stage of the project and for all deliverables
SoR not reviewed by an expert before procurement started	SoR should be reviewed for optimum technical viability
Timescales were too tight	Timescales should be realistic and allow appropriate contingency
The first iteration was provided too late	The first iteration should be drafted collaboratively throughout the UI workshops
ORR's partners [IMG and SCC] not involved early enough, delaying integration work	Involvement of all parties needs to be planned and scheduled from the outset

Offshore project management did not work	Project should be resourced locally, unless offshore resources work UK time, and have appropriate tools for managing people and deliverables
Too much work taken on by one individual	Resourcing must be appropriately and realistically assigned
CV's not provided for all project staff	Project team should not be signed off [during procurement] without CV's provided for all project members
No TNA of ORR's technical staff	Project team must conduct an early TNA of ORR technical skills, to ensure support and training is provided at the appropriate level
Product descriptions only provided for a few deliverables	Product descriptions should be provided for all deliverables
Solution design started with the Drupal interface	Must start with existing infrastructure and data, not the interface
Collaborative working relationship was inconsistent	Collaborative working must be consistent throughout the project - with support and guidance provided at all stages
ORR was tied to Drupal [as the only option] at an early stage	All avenues should be explored before a solution is committed to
The Club only provided one potential supplier	The Club should offer a range of suppliers
ORR had no sight or awareness of Steria's governance arrangements	Ensure early awareness of how the project team will govern the project, and monitor throughout
Project plan provided too late and did not meet requirements	Insist on project plan as a deliverable for sign off of first gate / payment milestone
ORR could not access Steria's QC system, which hampered UAT	ORR must have access to the UAT tools used by the project team
The Gap between UAT and go live was not long enough	Allow sufficient time for resolution of UAT defects

Source: Courtesy of the Office of Railway Regulators

Appendix 8: Research Method, Justification and Process Flow

Stage 1. Literature Review

Objectives:

- **Derive and synthesise the critical success factors (CSFs) relevant to BI implementation.**
- **Develop theoretical framework.**

Steps taken	Justification	Outcome
• Thoroughly review of BI and its CSFs in the literature	• To establish the development of previous research in the area of business intelligence implementation.	• Previous research generally focussed on singular or few factors in interview case study. • Relationship between critical success factors not well explored • Study to investigate a set of CSFs in multiple case studies for cross analysis.
• Derive most reoccurring critical success factors themes.	• Wide array of critical factors the literature. Needed to focus on identifying most relevant critical factors possibly having an impact on BI implementation success.	• Proposed sixteen factors that impact BI implementation including a new critical success factor variable added Researcher's observation. • Development of Research Theoretical Framework

Stage 2. Survey

Objectives:

- **Confirm CSF variables synthesised from literature review stage**
- **Explore the relationship between the critical success factors.**
- **Establish to what extent the CSF explain BI implementation success.**

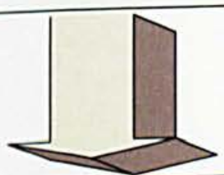
Steps taken	Justification	Outcome
• Choice of survey tool	• Purpose of research is to explore CSFs for BI, not to develop new measurements. Therefore pre-validated tools used. • Pre-validated tools increase validity & reliability of results	• Identification of survey tools that can be adopted and adapted. • Refinement of survey tool through Pilot testing
• Data collection through self-completed questionnaires, via online and post	• Use of self-completed questionnaires reaches wider audience.	•Completed questionnaires from respondents in organisations that had implemented business intelligence system.
• Statistical data analysis using factor analysis and regression analysis, aided by SPSS	• Confirm findings from large scale survey. • Rigorous and robust method common in positivist research.	• Establish the interdependence of the CSF variables • Establish the explanatory power of the CSF variables. • Findings from quantitative survey study to be discussed in Chapter seven

Stage3: Interview Case Study

Objectives:

- **Corroborate relevance of CSFs through qualitative interview case study**
- **Gain understand of the process and operationalization of the CSFs in live setting.**

Steps taken	Justification	Outcome
• Semi-structured interview with key players in 4 organisations that had implemented BI systems.	• Corroborate CSF relevance with survey findings from last stage • Allow for other constructs, and themes to be presented	• Confirmation of the relevance and applicability of the critical factors identified in stage one undertaken in real life setting.
• Clarification of terminology constructs and terms of reference by key players in industry.	• Confirm understanding of broad critical success factors CSF constructs e.g., project champion, etc., if understanding is similar to findings from literature	• Establish clear terms of reference and understanding of constructs
• Use of thematic content analysis on qualitative data aided by Computer aided qualitative data analysis software -COQDAS	• Common method of analysing qualitative data. • Establishing codes, commonalities and links between constructs	• Development of themes and categories regarding CSF and BI success outcome. • Identify new and emerging constructs and themes on BI implementation challenges and application of the critical success factors.



Stage 4Triangulation and Conclusions

Objectives:

- **Discuss, analyse and interpret findings in light of literature review and research objective**
- **Propose a Success Model of Business Intelligence Implementation**

Steps taken	Justification	Outcome
• Triangulation of survey and interview case study findings • Refinement of initial conceptual framework	• Discussion and verification of empirical findings with literature review and research objective. • Refinement of initial theoretical framework in light of empirical findings.	• Analysis and alignment of research findings with stated research objective. • Proposed Integrated Success Model of Business Intelligence Implementation. • Recommendation and conclusions

Source: Own

Appendix 9: Frequency Table on Critical Success Factors Responses

Critical Success Factors	Mean (1-5 Scale)	Std. Deviation	(%) Responses Scores SA (5)	A (4)	N (3)	D (2)	SD (1)
Clear Business case	4.61	0.616	66.7%	28.4%	3.9%	1.0%	0.0%
Data management and integration	4.29	0.739	45.1%	40.2%	13.7%	1.0%	0.0%
Management Support	4.27	0.773	42.6%	44.6%	10.8%	1.0%	1.0%
User participation	4.19	0.817	37.3%	49.0%	10.8%	1.0%	2.0%
Executive Sponsor	4.16	0.829	38.2%	43.1%	15.7%	2.0%	1.0%
Appropriate Team skills	4.15	0.750	32.4%	52.9%	12.7%	1.0%	1.0%
Project management	4.13	0.740	29.4%	57.8%	9.8%	2.0%	1.0%
Communication with stakeholders	4.12	0.957	36.3%	41.2%	14.7%	3.9%	2.0%
Adequate budget	4.09	0.662	25.5%	58.8%	14.7%	1.0%	0.0%
Managing change & Expectation	3.98	0.783	25.5%	51.0%	19.6%	3.9%	0.0%
User training	3.95	0.763	23.5%	51.0%	22.5%	2.9%	0.0%
Software selection & Support	3.76	0.949	21.6%	44.1%	24.5%	7.8%	2.0%
Technical infrastructure	3.72	0.883	20.6%	38.2%	33.3%	7.8%	0.0%
User intuition	3.67	0.894	16.7%	43.1%	32.4%	5.9%	2.0%
Implementation methodology	3.63	0.943	18.6%	36.3%	37.3%	4.9%	2.9%
Nature of organisation	3.47	0.996	15.8%	33.7%	33.7%	14.9%	2.0%
SD =Strongly Disagree							
D = Disagree							
N = Nuetral							
A = Agree							
SA = Strongly Agree							
Sample = 102							

Appendix 10: Frequency Table on BI Success Attributes Responses

BI System Success Attributes	Mean (1-5 Ranking)	Std Deviation	Percentage (%) Response Scores SA (5)	A (4)	N (3)	D (2)	SD (1)
Easy to use & Adaptable	4.46	0.659	51.5%	44.4%	3.0%	1.0%	0.0%
Better quality information	4.44	0.759	55.9%	30.4%	9.8%	1.0%	0.0%
Speedy information retrieval	4.13	0.751	31.3%	54.5%	10.1%	4.0%	0.0%
Support for Mobile BI devices	3.25	0.885	8.1%	28.3%	46.5%	15.2%	2.0%
Advanced data visualization	3.89	0.853	23.2%	46.5%	25.3%	4.0%	1.0%
Integrate with other systems	3.68	1.038	22.2%	40.4%	23.2%	11.1%	3.0%
Real time data analysis.	3.29	1.002	10.1%	34.3%	34.3%	17.2%	4.0%
Advanced predictive analytics	3.56	0.872	13.1%	40.4%	36.4%	9.1%	1.0%
SD =Strongly Disagree							
D = Disagree							
N = Nuetral							
A = Agree							
SA = Strongly Agree							
Sample = 102							

Appendix 11: Correlation Matrix

Correlation Matrix[a]

		Business case & vision	Management support	Executive sponsorship	Communication with stakeholders	Project management	Change management	Software selection & support	Technical infrastructure	Data management	Implementation methodology	Team skills	User participation	User training	User intuition
Correlation	Business case & vision	1.000	.245	.284	.223	.433	.224	.206	.137	.257	.251	.385	.339	.233	.146
	Management support	.245	1.000	.453	.170	.241	.096	.172	.171	.039	.240	.377	.272	.191	.216
	Executive sponsorship	.284	.453	1.000	.217	.183	.215	.149	.170	.241	.251	.368	.240	.274	.210
	Communication with stakeholders	.223	.170	.217	1.000	.480	.481	.288	.103	.220	.223	.195	.418	.241	.171
	Project management	.433	.241	.183	.480	1.000	.422	.326	.297	.208	.312	.291	.428	.328	.342
	Change management	.224	.096	.215	.481	.422	1.000	.313	.233	.215	.203	.178	.385	.282	.300
	Software selection & support	.206	.172	.149	.288	.326	.313	1.000	.554	.317	.530	.330	.353	.218	.322
	Technical infrastructure	.137	.171	.170	.103	.297	.233	.554	1.000	.274	.491	.409	.306	.229	.317
	Data management	.257	.039	.241	.220	.208	.215	.317	.274	1.000	.333	.287	.385	.275	.083
	Implementation methodology	.251	.240	.251	.223	.312	.203	.530	.491	.333	1.000	.521	.489	.293	.498
	Team skills	.385	.377	.368	.195	.291	.178	.330	.409	.287	.521	1.000	.541	.273	.304
	User participation	.339	.272	.240	.418	.428	.385	.353	.306	.385	.489	.541	1.000	.413	.307
	User training	.233	.191	.274	.241	.328	.282	.218	.229	.275	.293	.273	.413	1.000	.479
	User intuition	.146	.216	.210	.171	.342	.300	.322	.317	.083	.498	.304	.307	.479	1.000
Sig. (1-tailed)	Business case & vision		.007	.002	.013	.000	.012	.020	.086	.005	.006	.000	.000	.010	.073
	Management support	.007		.000	.045	.007	.169	.043	.043	.348	.008	.000	.003	.028	.015
	Executive sponsorship	.002	.000		.015	.034	.015	.068	.044	.008	.006	.000	.008	.003	.017
	Communication with stakeholders	.013	.045	.015		.000	.000	.002	.153	.013	.012	.025	.000	.008	.044
	Project management	.000	.007	.034	.000		.000	.000	.001	.019	.001	.002	.000	.000	.000
	Change management	.012	.169	.015	.000	.000		.001	.009	.016	.021	.038	.000	.002	.001
	Software selection & support	.020	.043	.068	.002	.000	.001		.000	.001	.000	.000	.000	.015	.001
	Technical infrastructure	.086	.043	.044	.153	.001	.009	.000		.003	.000	.000	.001	.011	.001
	Data management	.005	.348	.008	.013	.019	.016	.001	.003		.000	.002	.000	.003	.177
	Implementation methodology	.006	.008	.006	.012	.001	.021	.000	.000	.000		.000	.000	.001	.000
	Team skills	.000	.000	.000	.025	.002	.038	.000	.000	.002	.000		.000	.003	.001
	User participation	.000	.003	.008	.000	.000	.000	.000	.001	.000	.000	.000		.008	.001
	User training	.010	.028	.003	.008	.000	.002	.015	.011	.003	.001	.003	.000		.000
	User intuition	.073	.015	.017	.044	.000	.001	.001	.001	.177	.000	.001	.001	.000	

a. Determinant = .011

Correlations Matrix

CRITICAL SUCCESS FACTOR	Business case & vision	Management support	Executive sponsorship	Adequate Budget	Nature of organization	Communication with stakeholders	Project management	Change management	Software selection & support	Technical infrastructure	Data management	Implementation methodology	User participation	User training	User intuition	Team skills
Business case & vision	1															
Management support	.245*	1														
Executive sponsorship	.257**	.453**	1													
Adequate Budget	.329**	.148	.209*	1												
Nature of organization	.205*	.126	.163	.103	1											
Communication with	.213*	.170	.238*	.265**	.355**	1										
Project management	.436**	.241*	.144	.341**	.161	.440**	1									
Change management	.230*	.096	.172	.252*	.101	.439**	.431**	1								
Software selection & support	.207*	.172	.137	.287**	.136	.283**	.327**	.313**	1							
Technical infrastructure	.139	.171	.156	.247*	.168	.099	.298**	.235*	.554**	1						
Data management	.212*	.017	.199*	.108	.055	.146	.148	.181	.287**	.236*	1					
Implementation methodology	.257**	.240*	.202*	.386**	.191	.203*	.324**	.218*	.528**	.490**	.287**	1				
User participation	.343**	.272**	.205*	.299**	.234*	.402**	.435**	.392**	.353**	.307**	.335**	.476**	1			
User training	.233*	.191	.263**	.146	.188	.238*	.327**	.280**	.216*	.229*	.272**	.291**	.412**	1		
User intuition	.120	.216*	.272**	.234*	.307**	.197*	.289**	.245*	.300**	.293**	.105	.427**	.262**	.455**	1	
Team skills	.383**	.377**	.360**	.313**	.196*	.196*	.287**	.174	.330**	.408**	.225*	.512**	.536**	.272**	.295**	1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix 12: Initial Communalities

Communalities

	Initial	Extraction
Business case & vision	1.000	.513
Management support	1.000	.638
Executive sponsorship	1.000	.578
Nature of organization	1.000	.322
Communication with stakeholders	1.000	.662
Project management	1.000	.561
Change management	1.000	.558
Software selection & support	1.000	.614
Technical infrastructure	1.000	.620
Data management	1.000	.425
Implementation methodology	1.000	.682
Team skills	1.000	.628
User participation	1.000	.544
User training	1.000	.510
User intuition	1.000	.738
Adequate Budget	1.000	.356

Extraction Method: Principal Component Analysis.

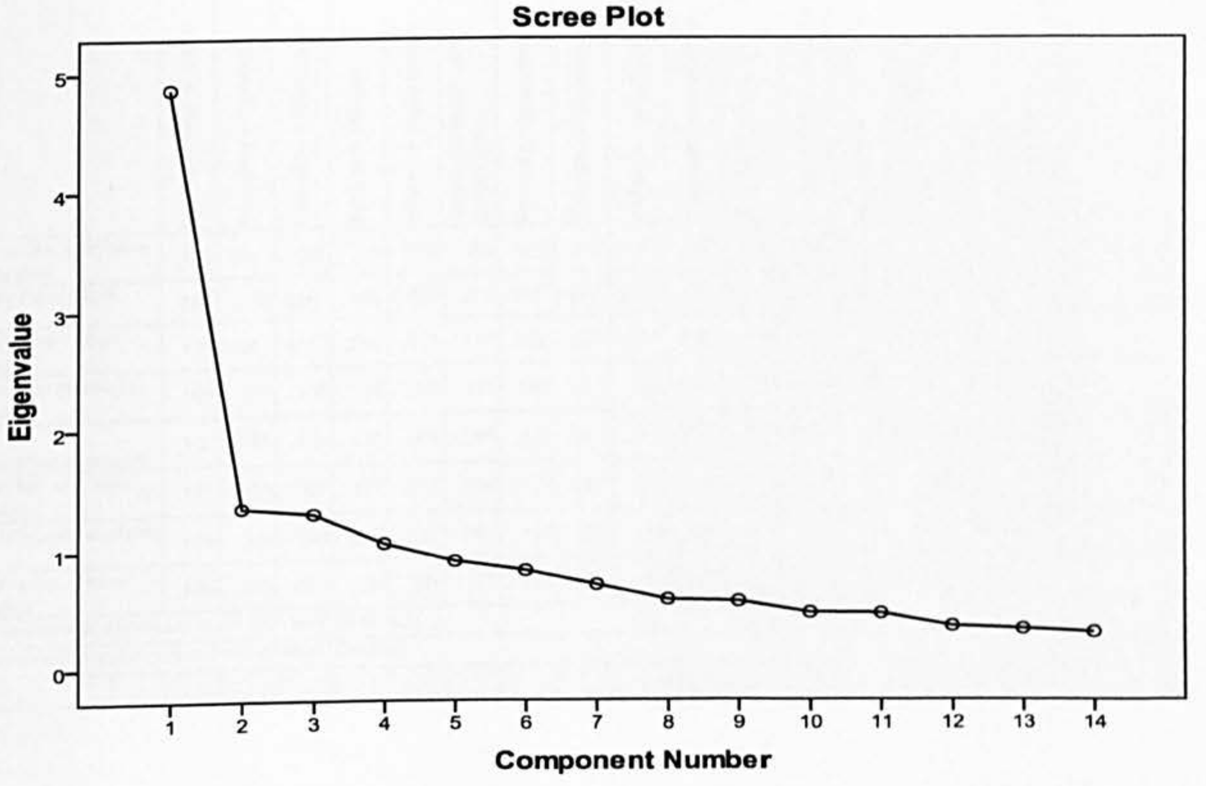
Appendix 13: Initial Un-rotated Factor Analysis Solution

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.237	32.733	32.733	5.237	32.733	32.733
2	1.330	8.314	41.047	1.330	8.314	41.047
3	1.294	8.087	49.134	1.294	8.087	49.134
4	1.088	6.798	55.932	1.088	6.798	55.932
5	.972	6.077	62.010			
6	.934	5.840	67.850			
7	.843	5.266	73.116			
8	.702	4.389	77.505			
9	.679	4.246	81.751			
10	.569	3.559	85.310			
11	.509	3.181	88.490			
12	.462	2.887	91.377			
13	.436	2.725	94.102			
14	.345	2.156	96.257			
15	.318	1.990	98.247			
16	.280	1.753	100.000			

Extraction Method: Principal Component Analysis.

Appendix 14: Factor Analysis Scree Plot



Appendix 15: Bivariate Correlation between CSF and BI Success Attributes.

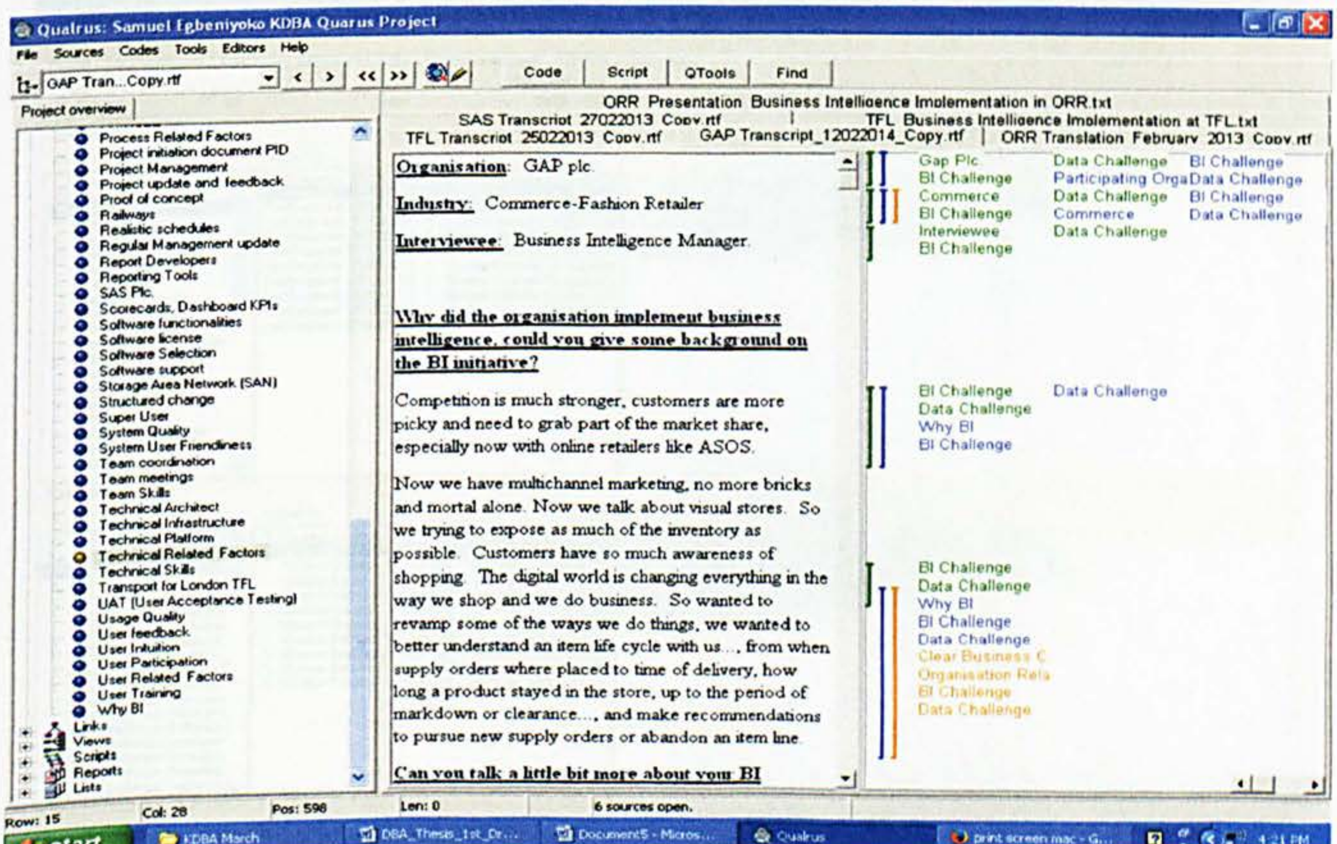
(1) Pearson's Correlation

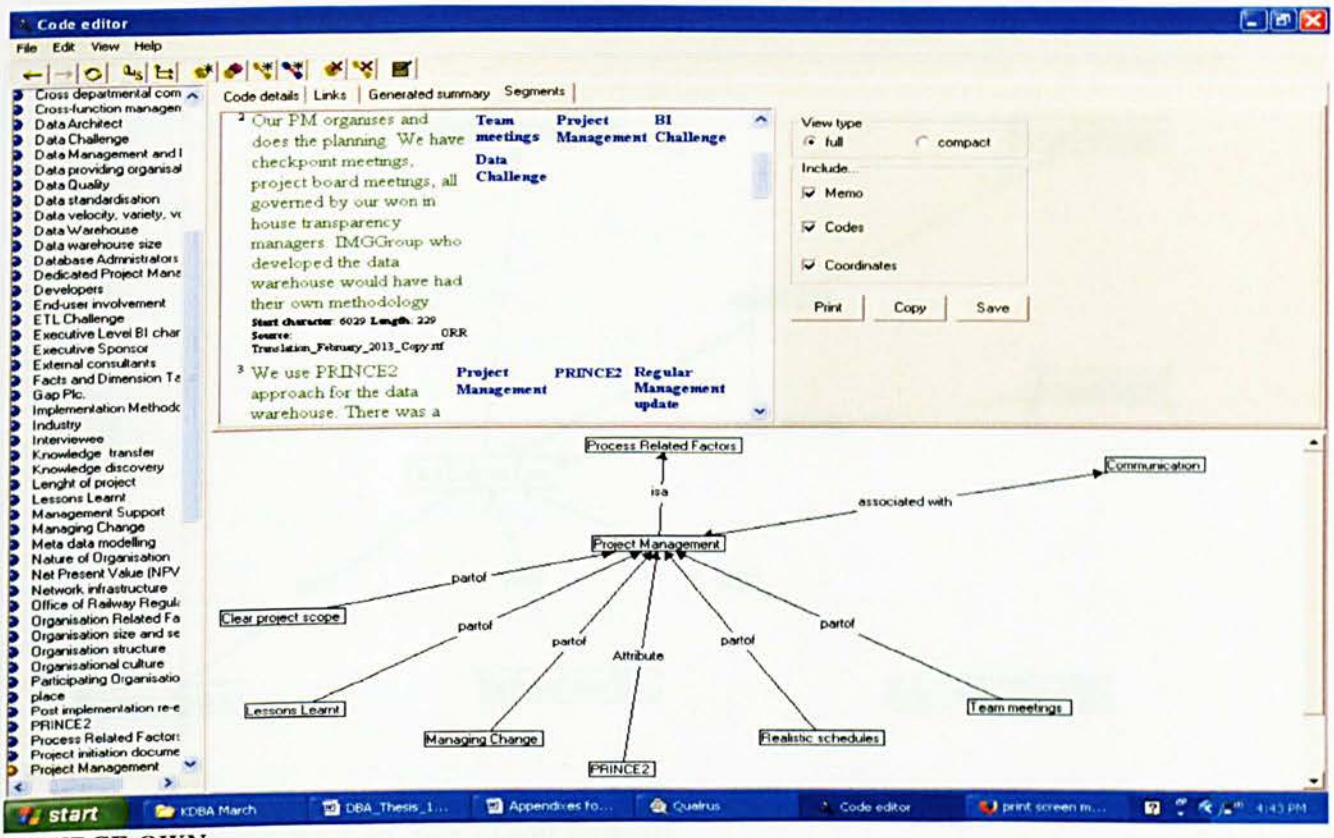
Critical Success Factors	Mean	Standard Deviation	Easy to use, adaptable and flexible	Quality information	Speedy information retrieval	Support for Mobile BI devices	Data visualization\scorecards\dashboard\KPIs	Integration with other systems	Real time data analysis	Advanced predictive analytics
Business case & vision	4.6078	0.61591	**.393****	**.354****	.178	-.096	.152	.197	.056	.050
Management support	4.2673	0.77319	**.412****	.245*	.293**	.144	.175	.210*	.074	.064
Executive sponsorship	4.1569	0.82947	**.336****	**.310****	**.422****	.099	.214*	.151	-.078	.037
Communication with stakeholders	4.1176	0.95745	.267**	**.317****	.190	.108	-.043	.070	.037	-.179
Project management	4.1275	0.74024	**.343****	**.390****	.263**	.015	.154	.183	.075	.084
Change management	3.9804	0.78325	.216*	**.428****	**.369****	.184	**.317****	.281**	.034	.062
Software selection & support	3.7549	0.94854	.273**	**.388****	.276**	.031	.271**	.222*	.060	.055
Technical infrastructure	3.7157	0.88304	.151	**.324****	.244*	.099	.284**	.225*	.044	**.313****
Data management	4.2745	0.82242	.116	**.300****	.157	-.036	.064	.123	.017	.064
Implementation methodology	3.6275	0.94315	.235*	**.370****	.178	-.036	.265**	.169	.182	**.328****
Team skills	4.1471	0.74988	.291**	.183	.240*	.042	.171	.186	.111	.168
User participation	4.1863	0.81727	.184	.278**	.148	-.001	.075	.182	.054	.030
User training	3.951	0.76271	.228*	.214*	.213*	.194	**.316****	**.385****	.148	.230*
User intuition	3.6667	0.89369	.171	.249*	.191	-.002	.232*	.084	.230*	.176
Pearson Correlation										
**. Correlation is significant at the 0.05 level (2-tailed).*										
***. Correlation is significant at the 0.01 level (2-tailed).*										
N = 102										

(2) Spearman's Bivariate Correlation

Spearman's rho (Non-Parametric Test)	Business case & vision	Management support	Executive sponsorship	Adequate Budget	Nature of organization	Communication with stakeholders	Project management	Change management	Software selection & support	Technical Infrastructure	Data management	Implementation methodology	Team skills	User participation	User training	User intuition	
Easy to use, adaptable and flexible	.225*	.281**	.208*	.110	.063	.158	.231*	.157	.258**	.087	.065	.177	.118	.030	.228*	.111	
Quality information	.220*	.122	.231*	.199*	-.033	.231*	.267**	.393**	.319**	.237*	.255*	.297**	.045	.141	.185	.229*	
Speedy information retrieval	.116	.289**	.408**	.215*	.012	.119	.213*	.308**	.302**	.235*	.158	.110	.136	.080	.208*	.177	
Support for Mobile BI devices	-.086	.141	.106	.102	.099	.137	.052	.162	.050	.086	.005	-.016	.045	.103	.196	.004	
Data visualization\scorecard	.100	.114	.129	.176	.056	-.046	.129	.295**	.299**	.261**	.075	.263**	.135	.095	.286**	.255*	
Integration with other systems	.177	.120	.097	.177	.072	.006	.107	.283**	.230*	.188	.156	.136	.117	.191	.397**	.080	
Real time data analysis	.056	.045	-.040	.224*	.250*	.057	.114	.059	.112	.093	.082	.217*	.140	.137	.159	.257*	
Advanced predictive analytics	.090	.058	.073	.156	.001	-.157	.116	.091	.015	.297**	.118	.322**	.136	.063	.233*	.222*	
**. Correlation is significant at the 0.01 level (2-tailed).																	
*. Correlation is significant at the 0.05 level (2-tailed).																	

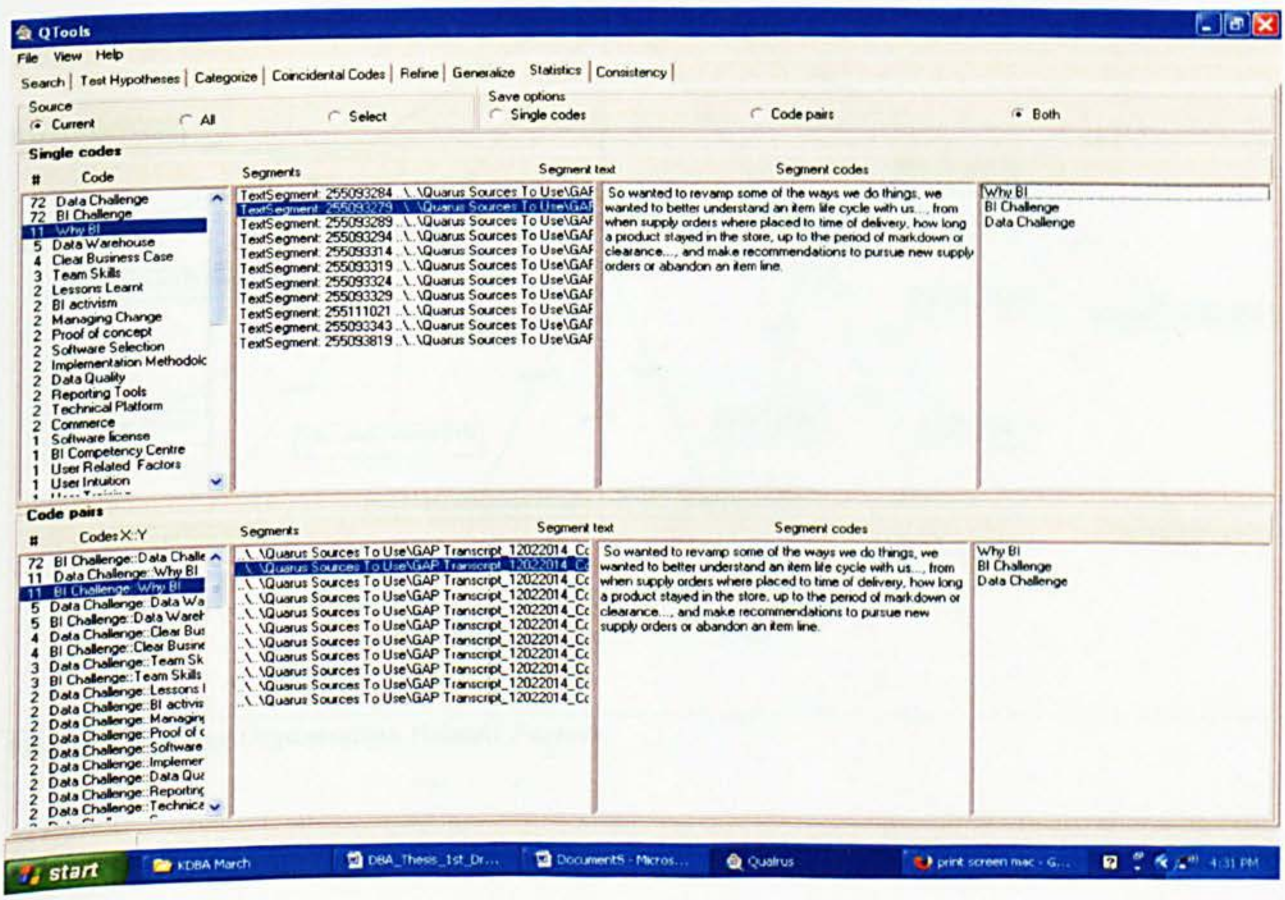
Appendix 16: Main Page Computer Aided Qualitative Data Coding with Qualrus



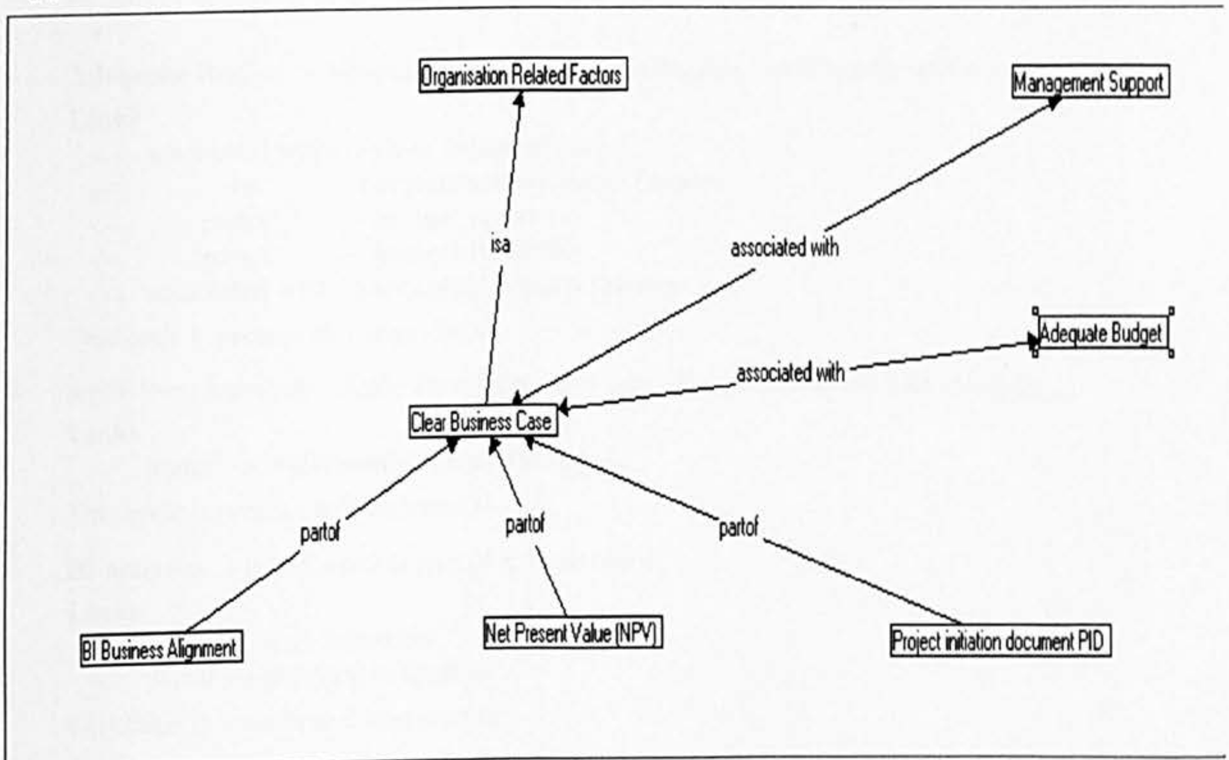


SOURCE OWN:

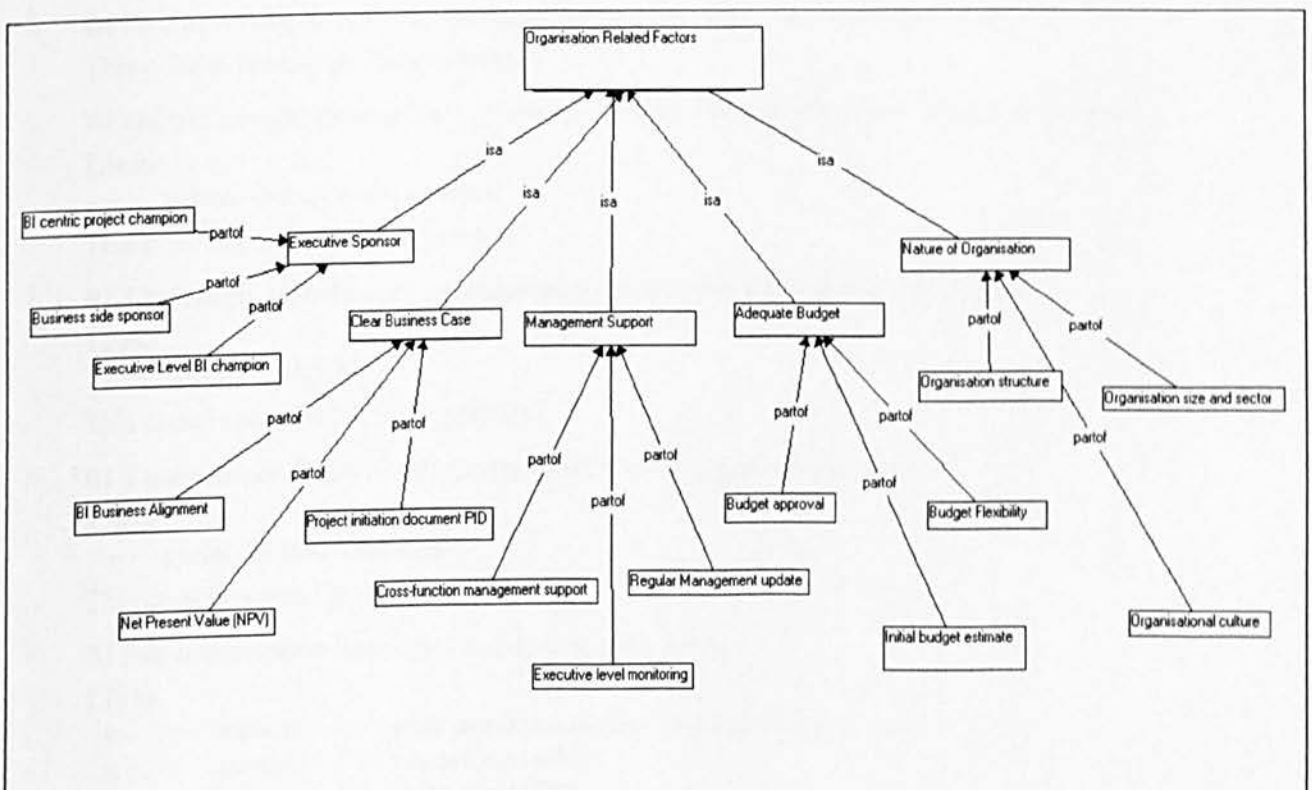
Appendix 17: Qualrus QTools Data Analysis



Appendix 18: Codes Links and Views



SOURCE OWN: Critical Factor View - Clear Business



View and Link on Organisation Related Factors.

Appendix 19: List of Qualitative Data Codes Used and Links

1 **Adequate Budget** - Adequate budget to support business intelligence initiative.

Links

<-- associated with--> **clear business case**
--- isa --> **organisation related factors**
<-- partof --- **budget approval**
<-- partof --- **budget flexibility**
<-- associated with--> **technical related factors**

This code is present in 1 segment(s).

2 **Agile Development** - Agile Development is part of implementation methodology

Links

--- partof--> **implementation methodology**

This code is present in 2 segment(s).

3 **BI activism** - BI activism is part of user intuition

Links

--- partof--> **user intuition**
--- partof--> **user participation**

This code is present in 2 segment(s).

4 **BI Benefit** - Benefits from initiating business intelligence project

This code is present in 14 segment(s).

5 **BI Business Alignment** - BI Business Alignment is part of Clear business Case

This code is present in 2 segment(s).

6 **BI centric project champion** - BI centric project champion is part of executive sponsor

Links

--- partof--> **executive sponsor**

This code is present in 1 segment(s).

7 **BI Challenge** - Challenges encountered in implementing business intelligence

Links

<-- partof--- **why bi**

This code is present in 292 segment(s).

8 **BI Competency Centre** - BI Competency Centre is part of user training

Links

--- partof--> **user training**

This code is present in 1 segment(s).

9 **BI Implementation Success** - not described in detail.

Links

<-- impacts --- **post implementation re-evaluation**
<-- partof --- **reporting tools**
<-- impacts --- **system quality**
<-- impacts --- **system user friendliness**
<-- impacts --- **usage quality**
<-- associated with--> **why bi**

This code is present in 4 segment(s).

10 **Budget approval** - Budget approval is of adequate budget
Links
--- partof--> **adequate budget**
This code is present in 1 segment(s).

11 **Budget Flexibility** - Budget Flexibility is part of adequate budget
Links
--- partof--> **adequate budget**
This code is present in 1 segment(s).

12 **Business side sponsor** - Business side sponsor is part of Executive Sponsor
Links
--- partof--> **executive sponsor**
This code is present in 4 segment(s).

13 **Change Approval Board (CAB)** - Change Approval Board (CAB) is part of Change Management
Links
--- partof--> **managing change**
This code is present in 2 segment(s).

14 **Clear Business Case** - Clear business case and BI vision.
Links
<-- associated with--> **management support**
--- isa --> **organisation related factors**
<-- associated with--> **adequate budget**
<-- partof --- **bi business alignment**
<-- partof --- **net present value (npv)**
<-- partof --- **project initiation document pid**
This code is present in 15 segment(s).

15 **Clear project scope** - Clear project scope is part of project management
Links
--- partof--> **project management**
This code is present in 2 segment(s).

16 **Commerce** - not described in detail.
Links
--- isa--> **industry**
<-- isa --- **sas plc.**
This code is present in 4 segment(s).

17 **Communication** - Communication is a process related critical factor
Links
--- isa --> **process related factors**
<-- associated with--> **project management**
<-- partof --- **consistent communication**
<-- partof --- **cross departmental communication**
<-- partof --- **project update and feedback**
This code is present in 3 segment(s).

18 **Communication method** - not described in detail.
This code is present in 4 segment(s).

19 **Consistent Communication** - Consistent Communication is part of communication

Links

--- partof --> **communication**

This code is present in 1 segment(s).

20 **Cross departmental communication** - Cross department communication is part of communication

Links

--- partof --> **communication**

This code is present in 2 segment(s).

21 **Cross-function management support** - Cross-functional management support is part of Management Support

Links

--- partof --> **management support**

This code is present in 1 segment(s).

22 **Data Architect** - Skills required to build a data warehouse and BI system

Links

--- partof --> **team skills**

This code is present in 1 segment(s).

23 **Data Challenge** - not described in detail.

Links

<-- partof --- **data velocity, variety, volume**

This code is present in 292 segment(s).

24 **Data Management and Integration** - Data management, integration and meta data

Links

<-- associated with --> **technical infrastructure**

--- isa --> **technical related factors**

<-- partof --- **data standardisation**

<-- partof --- **data velocity, variety, volume**

<-- partof --- **etl challenge**

<-- partof --- **meta data modelling**

<-- associated with --> **team skills**

This code is present in 6 segment(s).

25 **Data providing organisation** - not described in detail.

Links

--- partof --> **data standardisation**

This code is present in 3 segment(s).

26 **Data Quality** - Data quality is success quality expected of the BI system in terms of data reliability, completeness, real-time,

This code is present in 7 segment(s).

27 **Data standardisation** - Data standard and governance is part of data integration and integration

Links

--- partof --> **data management and integration**

<-- partof --- **data providing organisation**

This code is present in 4 segment(s).

28 **Data velocity, variety, volume** - Describe the challenges of data structure

Links

--- partof --> **data challenge**

--- partof --> **data management and integration**

This code is present in 2 segment(s).

29 **Data Warehouse** - Data Warehouse is part of Technical Infrastructure

Links

<-- associated with --> **technical infrastructure**

<-- associated with --> **facts and dimension table**

<-- associated with --> **meta data modelling**

<-- partof --- **scorecards, dashboard kpis**

This code is present in 11 segment(s).

30 **Data warehouse size** - not described in detail.

This code is present in 3 segment(s).

31 **Database Admnistrators** - Skills required to administer and manage BI data warehouse

Links

--- partof --> **technical skills**

This code is present in 2 segment(s).

32 **Dedicated Project Manager** - not described in detail.

This code is present in 3 segment(s).

33 **Developers** - Skills required to build a BI system

Links

--- partof --> **team skills**

This code is present in 2 segment(s).

34 **End-user involvement** - End user involvement is part of user participation

This code is present in 0 segment(s).

35 **ETL Challenge** - ETL (Data extraction, transformation and loading) is part of data management and integration

Links

--- partof --> **data management and integration**

This code is present in 3 segment(s).

36 **Executive Level BI champion** - Executive Level BI champion is part of a BI Executive Sponsor

Links

--- partof --> **executive sponsor**

This code is present in 1 segment(s).

37 **Executive Sponsor** - Executive sponsor and champion is an organisational related critical factor

Links

--- isa --> **organisation related factors**

<-- partof --- **bi centric project champion**

<-- partof --- **business side sponsor**

<-- partof --- **executive level bi champion**

This code is present in 5 segment(s).

38 **External consultants** - External consultant is part of team skills
Links
--- partof --> **team skills**
This code is present in 4 segment(s).

39 **Facts and Dimension Table** - Properties of data warehouse
Links
<-- associated with --> **data warehouse**
This code is present in 1 segment(s).

40 **Gap Plc.** - not described in detail.
This code is present in 1 segment(s).

41 **Implementation Methodology** - Implementation Methodology is a technical related critical factor
Links
--- isa --> **technical related factors**
<-- partof --- **agile development**
<-- partof --- **proof of concept**
This code is present in 4 segment(s).

42 **Industry** - Industrial sector in which participant organisation operate
Links
--- partof --> **participating organisation**
<-- isa --- **commerce**
<-- isa --- **railways**
This code is present in 3 segment(s).

43 **Interviewee** - Interview participant
This code is present in 5 segment(s).

44 **Knowledge transfer** - knowledge transfer is part of training
Links
--- partof --> **user training**
This code is present in 1 segment(s).

45 **Knowledge discovery** - End User BI knowledge discovery is part of user intuition
Links
--- partof --> **user intuition**
This code is present in 0 segment(s).

46 **Lenght of project** - not described in detail.
This code is present in 1 segment(s).

47 **Lessons Learnt** - Lessons learnt from project according to participant
Links
--- partof --> **project management**
This code is present in 17 segment(s).

48 **Management Support** - Management support is an organisational critical factor
Links
--- isa --> **organisation related factors**
<-- associated with --> **clear business case**
<-- partof --- **cross-function management support**

<-- partof --- **regular management update**

This code is present in 6 segment(s).

49 **Managing Change** - Managing change and expectation is a process related factor

Links

--- isa --> **process related factors**
--- partof --> **project management**
<-- partof --- **change approval board (cab)**
<-- partof --- **structured change**

This code is present in 4 segment(s).

50 **Meta data modelling** - Master data and definition about data

Links

--- partof --> **data management and integration**
<-- associated with --> **data warehouse**

This code is present in 3 segment(s).

51 **Nature of Organisation** - Nature of organisation in terms of size, culture, structure and industry is an organisational related factor

Links

--- isa --> **organisation related factors**
<-- partof --- **organisation size and sector**
<-- partof --- **organisation structure**
<-- partof --- **organisational culture**

This code is present in 2 segment(s).

52 **Net Present Value (NPV)** - Net Present Value (NPV) financial estimate is part of clear business case

Links

--- partof --> **clear business case**

This code is present in 1 segment(s).

53 **Network infrastructure** - Network infrastructure is part of technical infrastructure

Links

--- partof --> **technical infrastructure**

This code is present in 2 segment(s).

54 **Office of Railway Regulator** - not described in detail.

Links

--- isa --> **participating organisation**

This code is present in 2 segment(s).

55 **Organisation Related Factors** - Organisational related factor is a critical factor dimension

Links

<-- isa --- **adequate budget**
<-- isa --- **clear business case**
<-- isa --- **executive sponsor**
<-- isa --- **management support**
<-- isa --- **nature of organisation**

This code is present in 6 segment(s).

56 **Organisation size and sector** - Organisation size and sector is part of Nature of organisation

Links

--- partof--> **nature of organisation**

This code is present in 1 segment(s).

57 **Organisation structure** - Open, Flat and or Hierarchical structure part of Nature of Organisation

Links

--- partof--> **nature of organisation**

This code is present in 1 segment(s).

58 **Organisational culture** - Organisational culture is part of Nature of organisation

Links

--- partof--> **nature of organisation**

This code is present in 1 segment(s).

59 **Participating Organisation** - Industry in which organisations operate

Links

<-- partof--- **industry**
<-- isa --- **office of railway regulator**
<-- isa --- **sas plc.**
<-- isa --- **transport for London TfL**

This code is present in 5 segment(s).

60 **place** - location

This code is present in 0 segment(s).

61 **Post implementation re-evaluation** - not described in detail.

Links

--- impacts--> **bi implementation success**

This code is present in 3 segment(s).

62 **PRINCE2** - PRINCE2 is a professional accreditation and is part of Project Management

Links

--- Attribute--> **project management**

This code is present in 3 segment(s).

63 **Process Related Factors** - Process related factor is a factor dimension

Links

<-- isa--- **communication**
<-- isa--- **managing change**
<-- isa--- **project management**
<-- isa--- **team skills**

This code is present in 1 segment(s).

64 **Project initiation document PID** - Project initiation document PID is part of Clear Business Case attribute

Links

--- partof--> **clear business case**

This code is present in 0 segment(s).

65 **Project Management** - Project management in terms of scoping, time and delivery

Links

--- isa --> **process related factors**
<-- partof --- **clear project scope**

<-- associated with --> **communication**
<-- partof --- **lessons learnt**
<-- partof --- **managing change**
<-- Attribute --- **prince2**
<-- partof --- **realistic schedules**
<-- partof --- **team meetings**

This code is present in 8 segment(s).

66 **Project update and feedback** - Project updates and feedback is part of communication

Links

--- partof --> **communication**

This code is present in 0 segment(s).

67 **Proof of concept** - proof of concept is part of implementation methodology

Links

--- partof --> **implementation methodology**

This code is present in 5 segment(s).

68 **Railways** - not described in detail.

Links

--- isa --> **industry**
<-- partof --- **transport for London TfL**

This code is present in 2 segment(s).

69 **Realistic schedules** - Realistic task schedules is part of Project Management

Links

--- partof --> **project management**

This code is present in 0 segment(s).

70 **Regular Management update** - Regular Management update is part of Management Support

Links

--- partof --> **management support**

This code is present in 1 segment(s).

71 **Report Developers** - Technical Skills needed to implement BI system

Links

--- partof --> **technical skills**

This code is present in 1 segment(s).

72 **Reporting Tools** - not described in detail.

Links

--- partof --> **BI implementation success**
<-- partof --- **scorecards, dashboard, KPIs**

This code is present in 3 segment(s).

73 **SAS Plc.** - not described in detail.

Links

--- isa --> **commerce**
--- isa --> **participating organisation**

This code is present in 1 segment(s).

74 **Scorecards, Dashboard KPIs** - Business intelligence functionalities

Links

--- partof --> **data warehouse**
--- partof --> **reporting tools**

This code is present in 3 segment(s).

75 **Software functionalities** - Software functionalities is part software selection

Links

--- partof --> **software selection**

This code is present in 4 segment(s).

76 **Software license** - Software license is part of software selection

Links

--- partof --> **software selection**

This code is present in 2 segment(s).

77 **Software Selection** - Software selection and Support is a technical related factor

Links

--- isa --> **technical related factors**
<-- partof --- **software functionalities**
<-- partof --- **software license**
<-- partof --- **software support**
<-- associated with --> **team skills**
<-- partof --- **technical platform**

This code is present in 10 segment(s).

78 **Software support** - software support is part of software selection

Links

--- partof --> **software selection**

This code is present in 5 segment(s).

79 **Storage Area Network (SAN)** - Data Warehouse IT Infrastructure is part of Technical Infrastructure

Links

--- partof --> **technical infrastructure**

This code is present in 0 segment(s).

80 **Structured change** - structured change process is part of managing change and expectation

Links

--- partof --> **managing change**

This code is present in 1 segment(s).

81 **Super User** - Advanced user skill for BI system

Links

--- partof --> **team skills**

This code is present in 2 segment(s).

82 **System Quality** - System quality expected of the BI system in terms of System speed, integration with other systems, support for mobile, advanced predictive analysis

Links

--- impacts --> **BI implementation success**
<-- partof --- **system user friendliness**

This code is present in 10 segment(s).

83 **System User Friendliness** - Quality of BI system acceptance

Links

--- impacts --> **bi implementation success**
--- partof --> **system quality**

This code is present in 2 segment(s).

84 **Team coordination** - Team coordination is part of team skills

Links

--- partof --> **team skills**

This code is present in 1 segment(s).

85 **Team meetings** - Regular Team meetings is part of project management

Links

--- partof --> **project management**

This code is present in 1 segment(s).

86 **Team Skills** - Team skills in terms of technical ability and coordination

Links

<-- associated with --> **data management and integration**
--- isa --> **process related factors**
<-- associated with --> **software selection**
<-- partof --- **data architect**
<-- partof --- **developers**
<-- partof --- **external consultants**
<-- partof --- **super user**
<-- partof --- **team coordination**
<-- partof --- **technical skills**

This code is present in 7 segment(s).

87 **Technical Architect** - not described in detail.

This code is present in 1 segment(s).

88 **Technical Infrastructure** - Technical Infrastructure in terms of storage, network speed and other capability is a technical related factor

Links

--- isa --> **technical related factors**
<-- associated with --> **data management and integration**
<-- associated with --> **data warehouse**
<-- partof --- **network infrastructure**
<-- partof --- **storage area network (san)**

This code is present in 2 segment(s).

89 **Technical Platform** - not described in detail.

Links

--- partof --> **software selection**

This code is present in 7 segment(s).

90 **Technical Related Factors** - Technical Related Factor is a factor dimension

Links

<-- associated with --> **adequate budget**
<-- isa --- **data management and integration**
<-- isa --- **implementation methodology**
<-- isa --- **software selection**
<-- isa --- **technical infrastructure**

This code is present in 5 segment(s).

91 **Technical Skills** - Appropriate technical skills is part of team skill

Links

--- partof --> **team skills**

<-- partof --- **database administrators**

<-- partof --- **report developers**

This code is present in 2 segment(s).

92 **Transport for London TFL** - not described in detail.

Links

--- isa --> **participating organisation**

--- partof --> **railways**

This code is present in 2 segment(s).

93 **UAT (User Acceptance Testing)** - User Acceptance Testing (UAT) is part of user participation

Links

--- partof --> **user participation**

This code is present in 2 segment(s).

94 **Usage Quality** - Usage quality expected of the BI system in terms of Easy to Use and User Satisfaction

Links

--- impacts --> **bi implementation success**

This code is present in 0 segment(s).

95 **User feedback** - User feedback is part of user participation

Links

--- partof --> **user participation**

This code is present in 1 segment(s).

96 **User Intuition** - User intuition is a user related critical factor

Links

--- isa --> **user related factors**

<-- partof --- **bi activism**

<-- partof --- **knowledge discovery**

This code is present in 2 segment(s).

97 **User Participation** - User participation and involvement is a user related critical factor

Links

- isa --> **user related factors**

<-- partof --- **bi activism**

<-- partof --- **uat (user acceptance testing)**

<-- partof --- **user feedback**

This code is present in 2 segment(s).

98 **User Related Factors** - User related factor is critical factor dimension

Links

<-- isa --- **bi business alignment**

<-- isa --- **user intuition**

<-- isa --- **user participation**

This code is present in 2 segment(s).

99 **User Training** - User training and competencies is a critical factor

Links

<-- partof --- **bi competency centre**

<-- partof --- **knowledge transfer**

This code is present in 6 segment(s).

100 **Why BI** - The reason for undertaking business intelligence

Links

--- partof --> **bi challenge**

<-- associated with --> **bi implementation success**

This code is present in 22 segment(s).

Appendix 20: List of Codes and Interview Text Segments

Code name	Segment(s)	Segment Code(s)
BI Challenge	Source: GAP Transcript_12022014_Copy.rtf "Competition is much stronger, customers are more picky and need to grab part of the market share, especially now with online retailers like ASOS."	BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf "The digital world is changing everything in the way we shop and we do business"	BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf " Before now, we use to pull information from different systems into excel. It was not dynamic, not integrated report"	BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf "It was static, on daily, weekly, monthly."	BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf "I was task with implementing business intelligence solution to address some of the reporting challenges"	BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf	BI Challenge

	" Key to that was feasibility and what happen from the buying process, stocking, selling and the customer experience. We want to be able to monitor each stage and have an owner assigned to identify which of the stages gave problems. We wanted to better understand an item life cycle with us..., from when supply orders where placed to time of delivery, how long a product stayed in the store, up to the period of markdown or clearance..., and make recommendations to pursue new supply orders or abandon an item line "	
	Source: GAP Transcript_12022014_Copy.rtf "We check season, trend, time. So we can see the inventory, what is coming, what is in the warehouse, weeks in hand."	BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf " Cognos Reporting, Microstrategy, SQL Server, Business Systems tools, other departmental reporting tools."	Reporting Tools BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf "Business intelligence strategy around lesser reporting tools some of which are duplicates"	BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf " We wanted one version of truth. "	BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf "The implementation is not necessarily the issue, but the process of managing the data"	BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf "creating the data warehouse, getting the data into the data warehouse,"	BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf "the Meta data design and structures in fact the data warehouse part generally is the most difficult part. "	BI Challenge

Source: GAP Transcript_12022014_Copy.rtf "Data warehousing design is the most critical and challenging part accounting for about 80% of the business intelligence implementation effort."	BI Challenge Data Warehouse
Source: ORR Translation_February_2013_Copy.rtf "Restructure what we do, the way we do data analysis. · Introduce data quality, format and standard · Build a central data warehouse. "	BI Challenge
Source: ORR Translation_February_2013_Copy.rtf "There was no central point. Data dissemination used to be static spread sheets, cut and paste on web portals, undertaken by disparate teams and websites were hard to navigate. To proceed with the McDonald recommendation, we did 3 three things"	BI Challenge
Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Static spreadsheets Disparate teams and processes Hard to navigate websit"	BI Challenge
Source: SAS Transcript_27022013_Copy.rtf "Former systems were basically just reporting on existing data, without any form of data analysis, or correlating with data from other systems, this is the Gap BI filled. BI have evolved from DSS-MIS-EIS-BI system. While each of these does some form of what modern BI do, these former systems were basically more on specific functional area of analysis of the business. BI took it further to cross functionality, to gather or centralised functional area data for analysis, mining and reporting. So this is where BI comes in."	Why BI BI Challenge
Source: SAS Transcript_27022013_Copy.rtf "The first difficulty is the justifying the Business Case in some organisation. Undertaking the return on investment (RIO)	BI Challenge Clear Business Case

seems to be the most difficult to undertake at the initial stage. "	
Source: TFL Transcript_25022013_Copy.rtf "There were no clear way of defining and grouping data, and there were multiple definitions for the same thing, e.g., the word site, might mean something different for buses, and another thing for traffic control, and even another thing for cameras. The reports were repetitive, labour intensive and some financial records could take up to four weeks, with several analysts for different teams for buses, Tube, cameras and we all belong to the same traffic directorate"	BI Challenge
Source: TFL Transcript_25022013_Copy.rtf "The reports were repetitive, labour intensive and some financial records could take up to four weeks, with several analysts for different teams for buses, Tube, cameras and we all belong to the same traffic directorate"	BI Challenge
Source: TFL Transcript_25022013_Copy.rtf "Data was not really seen as an asset, it was something the analysts have to massage to get information out of. "	BI Challenge
Source: TFL Transcript_25022013_Copy.rtf "Multiple definitions for the same thing, e.g., the word site, might mean something different for buses, and another for traffic control, and even another thing for cameras"	BI Challenge
Source: TFL Transcript_25022013_Copy.rtf "We have challenges with static reports, we needed periodic changing reports. We have challenges with predictive analysis, We have lots of historic data, we wanted to be able to draw more intelligence from such data. "	BI Challenge Data Challenge
Source: TFL Transcript_25022013_Copy.rtf "We brought more data feed, from traffic centre, from camera piers, from congestion	BI Challenge

	charge, lots of extra data."	
	Source: TFL Transcript_25022013_Copy.rtf "We set out to do historic reporting and we analyse them in new ways deriving new intelligence for example, how many people were leaving the Olympics zone, how many people were leaving every 5 minutes."	BI Challenge
	Source: TFL_Business Intelligence Implementation at TFL.txt "Data Service must be: • Lightweight • Rapidly deployable • Customisable • Customer-led • Build on existing staff skills and knowledge "	BI Challenge
	Source: TFL_Business Intelligence Implementation at TFL.txt "Intelligence from the Traffic System "	BI Challenge
	Source: TFL_Business Intelligence Implementation at TFL.txt "Intelligence from the Traffic System Guidance and advice For the Public Planning data For TfL Information Exchange Network Development Analysis & Modelling Situational Network Management Data Management Operational Intelligence Awareness Real time Network Monitoring Dynamic Network Management "	BI Challenge
	Source: TFL_Business Intelligence Implementation at TFL.txt "Shared Common Calendar Shared Common Location Data snapped to Calendar and Location during ETL process. System Data "	Scorecards, Dashboard KPIs Reporting Tools BI Challenge
Why BI	Source: GAP Transcript_12022014_Copy.rtf "Competition is much stronger, customers are more picky and need to grab part of the market share, especially now with online retailers like ASOS. "	Why BI

Source: GAP Transcript_12022014_Copy.rtf " So wanted to revamp some of the ways we do things, we wanted to better understand an item life cycle with us..., from when supply orders where placed to time of delivery, how long a product stayed in the store, up to the period of markdown or clearance..., and make recommendations to pursue new supply orders or abandon an item line. "	Why BI
Source: GAP Transcript_12022014_Copy.rtf "So retailing is changing and customers have got so many avenues to shop. They can shop online, via iPod, etc. So the digital world is changing everything and price is king"	Why BI
Source: GAP Transcript_12022014_Copy.rtf " Like at ASOS, we wanted to know how much stock we had, how old they are. Before now, we use to pull information from different systems into excel. It was not dynamic, not integrated report"	Why BI
Source: GAP Transcript_12022014_Copy.rtf "Key to that was feasibility and what happen from the buying process, stocking, selling and the customer "	Why BI
Source: GAP Transcript_12022014_Copy.rtf "Key to that was feasibility and what happen from the buying process, stocking, selling and the customer experience."	Why BI
Source: GAP Transcript_12022014_Copy.rtf "We want to be able to monitor each stage and have an owner assigned to identify which of the stages gave problems"	Why BI
Source: GAP Transcript_12022014_Copy.rtf "We wanted to better understand an item life cycle with us..., from when supply orders where placed to time of delivery, how long a product stayed in the store, up to the period of	Why BI

markdown or clearance..., and make recommendations to pursue new supply orders or abandon an item line"	
Source: GAP Transcript_12022014_Copy.rtf "So right from the beginning of the process we need to know how much to buy, how much to deliver to shops, when, date and capture them in the business intelligence system. "	Why BI
Source: GAP Transcript_12022014_Copy.rtf "To consolidate multiple data reporting tools, reduce software licensing and administration and importantly have an end-to-end view of the buying and retailing (merchandising) process."	Why BI Software license Reporting Tools
Source: ORR Translation_February_2013_Copy.rtf "Before now as far back as 2009, the ORR was a like typical company, with data silos everywhere, using excel and Microsoft Access to access database. Much of data management process were manual, time consuming and offered limited business insight. There were no common data quality standards and processes, and no data sharing protocols in place "	Why BI Data Challenge
Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt " Disparate data management or analysis function Numerous and primitive 'databases' No defined processes or succession planning Inconsistent and duplicated data "	Data Challenge Why BI
Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Disparate data management or analysis function Numerous and primitive 'databases' No defined processes or succession planning Inconsistent and duplicated data January 2009, Study by Mott MacDonald recommended: 1. Restructuring information and analysis function 2. Introducing data quality standards and processes 3. Developing a central data	Why BI

warehouse "	
Source: SAS Transcript_27022013_Copy.rtf "Business intelligence basically comes from the need to provide data to the right people in the right format. One of the things modern BI does is in-depth data analysis that was not so much there before."	Why BI
Source: SAS Transcript_27022013_Copy.rtf "Former systems were basically just reporting on existing data, without any form of data analysis, or correlating with data from other systems, this is the Gap BI filled. BI have evolved from DSS-MIS-EIS-BI system. While each of these does some form of what modern BI do, these former systems were basically more on specific functional area of analysis of the business. BI took it further to cross functionality, to gather or centralised functional area data for analysis, mining and reporting. So this is where BI comes in."	Why BI BI Challenge
Source: TFL Transcript_25022013_Copy.rtf "There were lots of data, but no centralised data control and reporting, no interactions between systems. Lots of legacy historic systems owed by different teams"	Why BI
Source: TFL Transcript_25022013_Copy.rtf "Several analyst teams for different teams, e.g. buses, Tube, and we all belong to the same traffic directorate of TFL. No centralised data control and reporting. No interactions between systems. Reports were repetitive, labour intensive, financial year report took 4 weeks, enough was enough."	Why BI
Source: TFL Transcript_25022013_Copy.rtf "Data was not really seen as an asset, it was something the analysts have to massage to get information out of."	Why BI
Source: TFL_Business Intelligence Implementation at TFL.txt	Why BI

	"Data rich • Lacking data-derived intelligence • Limited, manual data processing "	
	Source: TFL_Business Intelligence Implementation at TFL.txt "Intelligence from the Traffic System Guidance and advice For the Public Planning data For TfL Information Exchange"	Why BI
Data Challenge	Source: GAP Transcript_12022014_Copy.rtf "data warehouse is about 5 terabyte."	Data Challenge
	Source: GAP Transcript_12022014_Copy.rtf "identify the data source"	Data Challenge
	Source: ORR Translation_February_2013_Copy.rtf "Before now as far back as 2009, the ORR was a like typical company, with data silos everywhere, using excel and Microsoft Access to access database. Much of data management process were manual, time consuming and offered limited business insight. There were no common data quality standards and processes, and no data sharing protocols in place "	Why BI Data Challenge
	Source: ORR Translation_February_2013_Copy.rtf "There is the issues data from different DPOs like I said earlier, there were issues of data standard, and ownership and governance of information coming from different organisations. "	Data Challenge
	Source: ORR Translation_February_2013_Copy.rtf "Make data validation much better. Have series of stages in data validation process, we still have some manual interaction in the process of validation."	Data Challenge Data Management and Integration
	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt	Data Challenge

" Disparate data management or analysis function Numerous and primitive 'databases' No defined processes or succession planning Inconsistent and duplicated data "	Why BI
Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Disparate, primitive and unstable data storage"	Data Challenge
Source: SAS Transcript_27022013_Copy.rtf "Data comes from different sources and sometimes identifying data sources, data structure and format, and cleansing data and bringing it to the end user in the way he wants it is key. The amount of work in data cleansing and integration is often underestimated in BI projects, which is a catalogue for failure_. "	Data Challenge
Source: TFL Transcript_25022013_Copy.rtf " Information held by very specific teams for various specific department, systems for traffic lights, systems for buses, systems that go over traffic lights, Camera piers, Assets management systems."	Data Challenge
Source: TFL Transcript_25022013_Copy.rtf "There were no clear way of defining and grouping data, and there were multiple definitions for the same thing, e.g., the word site, might mean something different for buses, and another thing for traffic control, and even another thing for cameras."	Data Challenge
Source: TFL Transcript_25022013_Copy.rtf "There was no drill down on data, no clear way of defining and grouping data, old system was repetitive. Financial report could take up to 4 weeks to prepare, management thought enough was enough."	Data Challenge Data standard
Source: TFL Transcript_25022013_Copy.rtf "We have challenges with static reports, we	BI Challenge

	needed periodic changing reports. We have challenges with predictive analysis, We have lots of historic data, we wanted to be able to draw more intelligence from such data. "	Data Challenge
	Source: TFL Transcript_25022013_Copy.rtf "Spatial data is the link that brought things together, there were binary data from traffic lights, about 700 files a day. These have to be unpacked using using c-code into a .csv file. We have Camera data from SQL, there are other data owed externally from the traffic directorate that are also coming in. So we design the solution around existing system."	Data Challenge
	Source: TFL Transcript_25022013_Copy.rtf "we have daily nightly data load of about 35 million records, 5 million and4 million records a day coming from different systems"	Data Challenge
	Source: TFL Transcript_25022013_Copy.rtf "Also in TFL there was a lot of data, and we were really concerned with the issue of data accuracy Data accuracy is key, work with data owners, on data accuracy, data owners remain data owners. Traffic incident management system, major data source for the BI system GIS data was also integrated onto the system "	Data Challenge Nature of Organisation
	Source: TFL Transcript_25022013_Copy.rtf "Meta data analysis,"	Meta data modelling Data Challenge
	Source: TFL_Business Intelligence Implementation at TFL.txt "There's a lot of data every day... Traffic detection at signals – 35 million rows Traffic light timing changes – 80,000 rows Traffic monitoring 1 million rows 200+ Accidents and events 5,500 road works permits/year Bus monitoring +5 million rows "	Data Challenge
Lessons Learnt	Source: GAP Transcript_12022014_Copy.rtf	Lessons Learnt

	"Be clear on what you want, what the purpose of the business intelligence system is for"	
	Source: GAP Transcript_12022014_Copy.rtf "Be sure who will use it, which will manage it, map out the business process"	Lessons Learnt
	Source: ORR Translation_February_2013_Copy.rtf "Number one is to do a solid business case"	Lessons Learnt
	Source: ORR Translation_February_2013_Copy.rtf "If you cannot get the business case sorted out, if you cannot really articulate what benefit the BI will bring to the organisation, then you probably do not need it"	Clear Business Case Lessons Learnt
	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Engage stakeholders at all times Sell the benefits to senior management Ensure the outputs support corporate outcomes Befriend experts within your / other organisations Consider all options You cannot quantify all benefits Allow plenty of time for user acceptance testing Take stock! "	Lessons Learnt
	Source: SAS Transcript_27022013_Copy.rtf "BI project must be well scoped"	Lessons Learnt
	Source: SAS Transcript_27022013_Copy.rtf "Executive Sponsor or Champion is very key. Somebody that will own the BI project at the client or business end, that will be the main point of contact from the supply perspective or IT implementation"	Executive Sponsor Executive Level BI champion Lessons Learnt
	Source: TFL Transcript_25022013_Copy.rtf "Get to grips with data governance, data quality issues"	Lessons Learnt Data Quality

	Source: TFL Transcript_25022013_Copy.rtf "Define business requirement clearly. Business forget how it was before and what they want changes constantly"	Lessons Learnt Clear project scope
	Source: TFL Transcript_25022013_Copy.rtf " Most of these information would need to be brought in. WE now recruit a lot of graduate trainings, but they have their own ways of doing things. The old and new need to match for the future."	Team Skills Lessons Learnt
	Source: TFL Transcript_25022013_Copy.rtf " time to take some stock before the next phase. "	Lessons Learnt
	Source: TFL Transcript_25022013_Copy.rtf "Get High level support initially. Without high level support and clear business case, you do not stand a chance."	Executive Level BI champion Management Support Lessons Learnt
	Source: TFL_Business Intelligence Implementation at TFL.txt "Differing granularity "	Lessons Learnt
	Source: TFL_Business Intelligence Implementation at TFL.txt "Small incremental delivery"	Lessons Learnt
	Source: TFL_Business Intelligence Implementation at TFL.txt "Identify champions early on "	Lessons Learnt Executive Sponsor
BI Benefit	Source: ORR Translation_February_2013_Copy.rtf "Network Provider Performance Report)"	BI Benefit

Source: ORR Translation_February_2013_Copy.rtf "Also, the quarterly health and safety reports on the railway, which we provide to the board also come from the data warehouse. The NPPR is automated. Also we have added OLAP cubes to their analysis. Externally, the public use the BI via the ORR portal to access some publicly available information"	BI Benefit
Source: ORR Translation_February_2013_Copy.rtf "When the web portal was launched for people to access some of the BI report, we made another person redundant. Now people can access the ORR information instead of sending request in for these reports."	BI Benefit
Source: ORR Translation_February_2013_Copy.rtf "More professionalism in reporting. For example, our inspectors request information, we want to creat it in an hour rather than weeks, in the past. · Now that we have got all these, they want more. · BI make data very visible, can do more with data, which is goo"	BI Benefit BI Implementation Success
Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Greater trust in data from sophisticated validation Easier and quicker for everyone to access data Resources freed up from automated processes Reputation enhanced by openness of data Stakeholder relations enhanced from engagement Efficiency savings from online reporting "	BI Benefit
Source: TFL Transcript_25022013_Copy.rtf "Freed up analyst time, analyst now have more time to do analysis, business have the data when they need it"	BI Benefit
Source: TFL Transcript_25022013_Copy.rtf "Before now, this kind of report could take	BI Benefit

	days or weeks to produce, and different analysts from different sections come with different report. Now we have consistency across reports. "	
	Source: TFL Transcript_25022013_Copy.rtf "We are now better able to plan and deploy more buses for example to specific sections, unrelated to bus issues based centralised traffic information or intelligence."	BI Benefit
	Source: TFL Transcript_25022013_Copy.rtf "We did not measure the benefit in monetary cost. Specifically, but we measure it in efficiency and man hours saved. For example, a report that would take 4 weeks to produce by 2 analyst, what we produce in the first 2 phases will save a 156 analysts effort in a day. One report could sometime take six weeks to produce, now we produce such report every day. "	BI Benefit
	Source: TFL_Business Intelligence Implementation at TFL.txt "Olympics and Paralympics • 180km of designated routes • 250km of 'alternative' routes • Over 1000 temporary changes: "	BI Benefit
	Source: TFL_Business Intelligence Implementation at TFL.txt "Physical junction modifications > Banned movements > Suspending traffic lights "	BI Benefit
	Source: TFL_Business Intelligence Implementation at TFL.txt "No athlete or official late for any events due to delays on the road network • Journey time reliability of 95.7%"	BI Benefit
	Source: TFL_Business Intelligence Implementation at TFL.txt "Data is now a valued departmental asset • Data is now actively used to support business decisions • First of kind transportation	BI Benefit

	business model • One source of the truth (well nearly) "	
	Source: TFL_Business Intelligence Implementation at TFL.txt "BI is accessible and responsive • Customers self-serve • Value for money"	BI Benefit
Clear Business Case	Source: GAP Transcript_12022014_Copy.rtf " The business case only become as good after the project is delivered. There could be difficulty in evaluating benefits, but it becomes very clear after the project is done and delivering."	Clear Business Case
	Source: GAP Transcript_12022014_Copy.rtf " A good business case would be to deliver better quality data. "	Clear Business Case
	Source: ORR Translation_February_2013_Copy.rtf "We did full cost benefit analysis, and did full business case including Net Present value NPV"	Clear Business Case Net Present Value (NPV)
	Source: ORR Translation_February_2013_Copy.rtf "We had to undertake the net present value NPV of the project, where we demonstrated that over a period of five years, there would be significant savings from making five roles redundant, which could be deployed to other uses within the organisation"	Clear Business Case
	Source: ORR Translation_February_2013_Copy.rtf " I have to write so many business case and Net Present Value on benefit on it to the railway, to the government, this goes to the sponsor, and then it goes to the executive committee and then to the board before it is approved for financing."	Clear Business Case
	Source: ORR	Clear Business

Translation_February_2013_Copy.rtf "If you cannot get the business case sorted out, if you cannot really articulate what benefit the BI will bring to the organisation, then you probably do not need it"	Case Lessons Learnt
Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Capability assessment "	Clear Business Case
Source: SAS Transcript_27022013_Copy.rtf "The first difficulty is the justifying the Business Case in some organisation. Undertaking the return on investment (RIO) seems to be the most difficult to undertake at the initial stage. "	BI Challenge Clear Business Case
Source: SAS Transcript_27022013_Copy.rtf " So that need for BI should be identified at the very beginning of the project to justify the initiative or business case. SAS can help clients identify their return on investment "	Clear Business Case
Source: SAS Transcript_27022013_Copy.rtf "Clients and implementers most clearly define the functionality expectations, to avoid PR creep"	Clear project scope Clear Business Case Project Management
Source: TFL Transcript_25022013_Copy.rtf "Sometimes, there is constant fighting between IT and business, now we have a BI uniting IT. They provide hep with project planning, IT infrastructure, thy provide assistance with data governance and new BI initiative. For this project, the BI was with the business rather than IT. There was a BI project delivered by IT in the past that did not meet up with expectation, mainly because it was more driven by IT. "	BI Business Alignment Business side sponsor Clear Business Case

	Source: TFL Transcript_25022013_Copy.rtf "The traffic director was the project champion, and the project was part of the "traffic intelligence" project being sponsored by the traffic director and was the champion to the project... "	Clear Business Case
Project Management	Source: GAP Transcript_12022014_Copy.rtf " The implementation itself is not necessarily the problem, but managing the process"	Project Management
	Source: ORR Translation_February_2013_Copy.rtf "We use PRINCE2 approach for the data warehouse. There was a clear project implementation schedules and planning managed by a dedicated project manager who."	Project Management PRINCE2 Regular Management update
	Source: ORR Translation_February_2013_Copy.rtf "Our PM organises and does the planning. We have checkpoint meetings, project board meetings, all governed by our won in house transparency managers. IMGGroup who developed the data warehouse would have had their own methodology."	Team meetings Project Management
	Source: SAS Transcript_27022013_Copy.rtf " SAS has all its PM working at client sites, to help with communicating business requirement to IT team, undertaking resourcing and monitoring project delivery."	Project Management
	Source: SAS Transcript_27022013_Copy.rtf "SAS has a PM for every project and SAS PM Stay and work at client site, attending their meetings and passing communication through and fro. SAS PM are PRINCE2 qualified"	Project Management PRINCE2
	Source: SAS Transcript_27022013_Copy.rtf "Now the issue is, they might expect that the	Project Management

	new request is part of the existing charge. Of course, it might be a minor request or change, that might not be coasted or c hared. But there might be other situation that are chargeable and requires the client to pick up the bills. So it is important that the scope is well defined and agreed, and an additional to agreed delivery is signed off "	Realistic schedules
	Source: SAS Transcript_27022013_Copy.rtf "Clients and implementers most clearly define the functionality expectations, to avoid PR creep"	Clear project scope Clear Business Case Project Management
	Source: TFL Transcript_25022013_Copy.rtf "The PM was taking care of the communication. The actual BI team was a small team, and so it was much easier to keep the communication and engagement. We knew what we wanted, we knew the time scale, we knew what to expect. "	Project Management
	Source: TFL Transcript_25022013_Copy.rtf "We had a PM, he was PRINCE2. WE kept things simple, we kept risk logs."	Project Management
	Source: TFL Transcript_25022013_Copy.rtf "We kept our time scale very short in days. They had very short delivery time scales, and this had to be managed within the project."	Project Management
Data Warehouse	Source: GAP Transcript_12022014_Copy.rtf "We built our business intelligence system on data warehouse backend platform."	Data Warehouse Technical Platform
	Source: GAP Transcript_12022014_Copy.rtf "data warehouse is about 5 terabyte"	Data Warehouse

Source: GAP Transcript_12022014_Copy.rtf "This will usually take about 80%"	Data Warehouse
Source: GAP Transcript_12022014_Copy.rtf "Data warehousing design is the most critical and challenging part accounting for about 80% of the business intelligence implementation effort."	BI Challenge Data Warehouse
Source: ORR Translation_February_2013_Copy.rtf "We built a data warehouse. The data warehouse was built on Microsoft SQL Server Platform, with SSRS, SSIS and the ORR portal sitting on top of that portal. There is a firewall between the portal and the data warehouse."	Data Warehouse
Source: ORR Translation_February_2013_Copy.rtf "IMGGroup who developed the data warehouse"	Data Warehouse External consultants
Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Master package Warehouse package Data warehouse Report Builder Data Portal website "	Data Warehouse Meta data modelling
Source: TFL Transcript_25022013_Copy.rtf "Spatial data is the link that brought things together. There were binary data from traffic lights, about 700 files a day. These have to be unpacked using c-code into a .csv file. We have Camera data from SQL, there are other data owed externally from the traffic directorate that are also coming in. So we design the solution around existing system. Total database size about 2 terabyte, we have daily nightly data load of about 35 million records, 5 million and4 million records a day coming from different systems. "	Data Warehouse
Source: TFL_Business Intelligence Implementation at TFL.txt	Data Warehouse

	"Data Hub Data Hub Processes Landing Area Data Feeds Raw Data Transformation and Alignment Aggregation Business Rules "	ETL Challenge
	Source: TFL_Business Intelligence Implementation at TFL.txt "Facts / Measures Location Spatial / Network Model Data Model Matching Data to Reality Monitoring the impact of street works "	Data Warehouse Data standard ETL Challenge
System Quality	Source: GAP Transcript_12022014_Copy.rtf "The business intelligence technology should be flexible to allow drill down to different hierarchies like product hierarchies, regional hierarchies"	System Quality
	Source: SAS Transcript_27022013_Copy.rtf "The second would be the system quality. In terms of responses and how fast, this is key for both users and IT perspective. In terms of tools availability and functionality, this is key from the perspective of the software vendor. The more functionality and availability the software has, there more inclusive functions to charge for. "	System Quality
	Source: SAS Transcript_27022013_Copy.rtf " SAS deploy BI on the cloud, and offer cloud services of SAS BI component on pay as you go basis."	System Quality
	Source: SAS Transcript_27022013_Copy.rtf "The system must be user friendly, SAS have experience of deploying user quality solution, "	System Quality
	Source: SAS Transcript_27022013_Copy.rtf "System or technical quality and user friendliness. In terms of priority, user friendliness is a higher quality to the end-user. However, some of such users might not be in position or expiree or knowledgeable enough to give judgement in terms of quality of the BI	System Quality

	solution"	
	Source: SAS Transcript_27022013_Copy.rtf "Mobile BI is also the future and expect more than 50% of BI technology to be delivered in mobile devices. "	System Quality
	Source: TFL Transcript_25022013_Copy.rtf "The way you present data, might change the way people view and interpreted the data. This is what business intelligence systems is all about"	System Quality
	Source: TFL Transcript_25022013_Copy.rtf "Mobile data deployed via iPad during the games"	System Quality
	Source: TFL_Business Intelligence Implementation at TFL.txt " Visualisation important "	System Quality
Data Management and Integration	Source: ORR Translation_February_2013_Copy.rtf "Most challenging is testing. Test a lot in UAT. If you do not get thorough with testing, and have signed of UAT, the company will say you have signed it off, and so not coming back. So testing is absolutely critical. "	Data Management and Integration
	Source: ORR Translation_February_2013_Copy.rtf "Make data validation much better. Have series of stages in data validation process, we still have some manual interaction in the process of validation."	Data Challenge Data Management and Integration
	Source: SAS Transcript_27022013_Copy.rtf "Data integration is the most. Sometimes, people underestimate the amount of effort required for data cleansing and integration"	Data Management and Integration
	Source: SAS Transcript_27022013_Copy.rtf	Data

	"SAS has its own data integrator too for managing clients data. SAS data integrator will pull data from sources to intermediate environment, do the necessary transformation and ready for data analysis, using the SAS data analysis tool"	Management and Integration
	Source: SAS Transcript_27022013_Copy.rtf "Noted that SAS started to be a data tool integrator supply company. SAS supply their data integrator tool to move data from point to point,"	Data Management and Integration
	Source: TFL Transcript_25022013_Copy.rtf "We use Hyperion BI reporting suite, which is now owned by Oracle. Feed data into the Entree mapping system "	Data Management and Integration
	Source: TFL Transcript_25022013_Copy.rtf "we still have to deal with the issue of data format and standardisation in the BI system, and this was taken care by the data integration and transformation functionality within the Oracle solution"	Data Management and Integration
	Source: TFL Transcript_25022013_Copy.rtf "Ways to integrate the system through location, through time and part of a wider project, the intelligence traffic system. GIS data now integrated onto the system and now used across all department."	Data Management and Integration
Executive Sponsor	Source: GAP Transcript_12022014_Copy.rtf "You cannot deliver business intelligence system as a departmental project; this is where the project champion is extremely important"	Executive Sponsor
	Source: ORR Translation_February_2013_Copy.rtf "We have SIRO, Senior Independent Responsibility Owner, who is like the project champion. "	Executive Sponsor

	Source: ORR Translation_February_2013_Copy.rtf "This is railway and we do some dull stuff. To galvanise interest in the project, we got we wanted and who got clout on the project board. They help to spread interest at the directorate level"	Executive Sponsor Management Support
	Source: SAS Transcript_27022013_Copy.rtf "This is key to understanding why the needed BI. This also important to get an executive sponsor. SAS insist on having an executive sponsor for the BI project, and as far SAS are concerned, is one of the most critical factor. "	Executive Sponsor
	Source: SAS Transcript_27022013_Copy.rtf " SAS will not undertake an implementation for a client if they are no identifiable project sponsor "	Executive Sponsor
	Source: SAS Transcript_27022013_Copy.rtf "Executive Sponsor or Champion is very key. Somebody that will own the BI project at the client or business end, that will be the main point of contact from the supply perspective or IT implementation"	Executive Sponsor Executive Level BI champion Lessons Learnt
	Source: TFL_Business Intelligence Implementation at TFL.txt "Identify champions early on "	Lessons Learnt Executive Sponsor
Management Support	Source: ORR Translation_February_2013_Copy.rtf "This is railway and we do some dull stuff. To galvanise interest in the project, we got we wanted and who got clout on the project board. They help to spread interest at the directorate level"	Executive Sponsor Management Support
	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt	Management Support

	"1. Presented recommendations to stakeholders 2. Developed a business case and cost-benefit analysis 3. Attained approval from ORR's executive"	
	Source: TFL Transcript_25022013_Copy.rtf "For the first time there was a clear directive from the very top to get this project done, to get the process of report and analysing centralised automated, and remove any manual steps. There was a clear support for the project, coming from the director of the traffic directorate, and the overall traffic intelligence project, in fact had the support of the Mayor, Boris Johnson."	Management Support
	Source: TFL Transcript_25022013_Copy.rtf "We got the managers from other department supplying data in involved, also because it was a high profile project support by the director, it was easy to get them involved"	Management Support
	Source: TFL Transcript_25022013_Copy.rtf "This has the clear support of the mayor Boris Johnson. There was a need to automate reports"	Management Support
	Source: TFL Transcript_25022013_Copy.rtf "Get High level support initially. Without high level support and clear business case, you do not stand a chance."	Executive Level BI champion Management Support Lessons Learnt
Software Selection	Source: GAP Transcript_12022014_Copy.rtf "Again, getting the right technical software is not enough that organisations have to get their requirements right, and scope the delivery well. Perhaps d a clear proof of concept, do that first. "	Software Selection
	Source: GAP Transcript_12022014_Copy.rtf "f you want users to have self service, what	Proof of concept Software

	does that mean? You want mobile business intelligence what does that mean, and at what cost. You want a Wi-Fi enabled in your business intelligence system, b then how does it work with the chosen software? All these must be demonstrated first before you plug in to particular software. "	Selection
	Source: SAS Transcript_27022013_Copy.rtf "It is important to consider integration of tools and it could be a problem where organisation has little understanding of the tools they select, as they are so many software vendors pushing their products. "	Software Selection
	Source: SAS Transcript_27022013_Copy.rtf " SAS can fit with any underlying technical infrastructure, but it is important to consider integration of tools and it could be a problem where organisation have little understanding of the tools they select, as they are so many software vendors pushing their product. Selecting an end to end solution make it easier to deploy. "	Software Selection
	Source: SAS Transcript_27022013_Copy.rtf "The benefit of using the package software is, if you have to upgrade, you do it once across all tools, and SAS will supply the latest version of the software, most of the time at no extra cost as long as they pay their yearly software renewal fee. If you mix and match tools in the implementation, then you have multiple and difference upgrades to make and at different times, which could be disrupting"	Software support Software Selection
	Source: TFL Transcript_25022013_Copy.rtf "We use Oracle BI suite purely because it integrated very well with the GIS database system that was already in place. "	Software Selection Software support Software functionalities
Data Quality	Source: GAP Transcript_12022014_Copy.rtf	Data Quality

	"Data needs to be accurate, quality accurate data end to end."	Data standard
	Source: GAP Transcript_12022014_Copy.rtf "Real time data is becoming more and more important in different ways"	Data Quality
	Source: ORR Translation_February_2013_Copy.rtf "Data standardisation · Data quality to be unparallel "	Data Quality Data standard BI Implementation Success
	Source: SAS Transcript_27022013_Copy.rtf "The first would be data quality. "	Data Quality
	Source: TFL Transcript_25022013_Copy.rtf "Data quality is important, correct complete information"	Data Quality
	Source: TFL Transcript_25022013_Copy.rtf "Get to grips with data governance, data quality issues"	Lessons Learnt Data Quality
Interviewee	Source: GAP Transcript_12022014_Copy.rtf "Business Intelligence Manager."	Interviewee
	Source: ORR Translation_February_2013_Copy.rtf "Business Intelligent Manager "	Interviewee
	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Chris Fieldsend, Business Intelligence Manager, Office of Rail Regulation"	Interviewee
	Source: SAS Transcript_27022013_Copy.rtf	Interviewee

	" Res-Sales Evaluation Manager"	
	Source: TFL Transcript_25022013_Copy.rtf "Principal Developer"	Interviewee
	Source: TFL_Business Intelligence Implementation at TFL.txt "Chris Duffield Principle Developer"	Interviewee
BI Implementation Success	Source: ORR Translation_February_2013_Copy.rtf "Data standardisation · Data quality to be unparallel "	Data Quality Data standard BI Implementation Success
	Source: ORR Translation_February_2013_Copy.rtf "More professionalism in reporting. For example, our inspectors request information, we want to create it in an hour rather than weeks, in the past. · Now that we have got all these, they want more. · BI make data very visible, can do more with data, which is goo"	BI Benefit BI Implementation Success
	Source: SAS Transcript_27022013_Copy.rtf " The first would be data quality. This is quality is really key, garbage in garbage out. The quality of data reflects the use of information and decision. From management perspective, data quality is top priority. The second would be the system quality. In terms of responses and how fast, this is key for both users and IT perspective. In terms of tools availability and functionality, this is key from the perspective of the software vendor. The more functionality and availability the software has, there more inclusive functions to charge for. System quality is also important from the perspective of the end users and business, such that the system could be delivered in different format, especially now that we talking about cloud technology today. SAS deploy BI on the cloud, and offer cloud	BI Implementation Success

	services of SAS BI component on pay as you go basis. "	
	Source: TFL Transcript_25022013_Copy.rtf " Success of BI must be able to provide the answers sought of data, and provide insight of what they have not thought about before. The way you present data, might change the way people view and interpreted the data. This is what business intelligence systems is all about. For example, we have gone from high level rows of records in tables, to high level data maps, which brings different understanding and perspective to data. Data quality is important, correct complete information Data mining, not yet deployed. Mobile data deployed via iPad during the games "	BI Implementation Success
	Source: TFL Transcript_25022013_Copy.rtf "Success of BI must be able to provide the answers sought of data, and provide insight of what they have not thought about before"	BI Implementation Success
Communication method	Source: ORR Translation_February_2013_Copy.rtf "Staff meetings to talk about it. · Newsletters. · Internal presentations, and it just began to stick and generate interest."	Communication method
	Source: SAS Transcript_27022013_Copy.rtf "Communication is very critical to any project. There should be "a clear point of contact and having a strong and structured communication process was crucial for success. "	Communication Communication method
	Source: SAS Transcript_27022013_Copy.rtf "So there is the need to have someone, who can comminute the business requirement to the IT people to implement, and also who can communicate the IT specifics to the business, and bring feedback. The PM would normally do that, but there could also be a business or functional or solution analyst for the project who understand both worlds that would undertake this role."	Communication method

	Source: TFL Transcript_25022013_Copy.rtf "Initially it was very informal. "	Communication method
	Source: TFL Transcript_25022013_Copy.rtf "Initially it was very informal. We had a very good PM. He was our interface with management."	Communication method
Managing Change	Source: GAP Transcript_12022014_Copy.rtf " You just have to prove it to them; you have to find ways to get them on board. "	Managing Change
	Source: GAP Transcript_12022014_Copy.rtf "Beside, you need to set right expectation mechanism on what the BI solution will address. "	Managing Change
	Source: SAS Transcript_27022013_Copy.rtf "Change management is important and needs to be in place to monitor the scope. Sometime, there might be an agreement with client to implement a piece of work, and during the process they might see further possibility and might want to incorporate that also."	Managing Change
	Source: SAS Transcript_27022013_Copy.rtf "Where change and expectations are not well managed, this is where things go wrong most times"	Consistent Communication Managing Change
	Source: TFL Transcript_25022013_Copy.rtf "What customer see today is not what they want to see tomorrow, therefore the analyser has to be flexible"	Managing Change
Proof of concept	Source: GAP Transcript_12022014_Copy.rtf " Perhaps d a clear proof of concept, do that first."	Proof of concept
	Source: GAP Transcript_12022014_Copy.rtf	Proof of concept

	"f you want users to have self service, what does that mean? You want mobile business intelligence what does that mean, and at what cost. You want a Wi-Fi enabled in your business intelligence system, b then how does it work with the chosen software? All these must be demonstrated first before you plug in to particular software. "	Software Selection
	Source: TFL Transcript_25022013_Copy.rtf "We worked flat-out, it was a proof of concept but used by a small team"	Proof of concept
	Source: TFL Transcript_25022013_Copy.rtf "We kept reminding ourselves when the prototype phase should finish. If people have any problem or clarification, they contact the PM,"	Proof of concept
	Source: TFL Transcript_25022013_Copy.rtf "Initially we were our boss, we were very small, wanted to the pilot stage delivered and had the flexibility and would do different things differently. Now that the pilot is gone live, we try to formalise things. "	Proof of concept
Team Skills	Source: GAP Transcript_12022014_Copy.rtf "MicoStrategy Team to help us deliver the business intelligence Reports"	Team Skills
	Source: GAP Transcript_12022014_Copy.rtf "Besides it require greater skill sets especially around statistical analysis."	Team Skills
	Source: SAS Transcript_27022013_Copy.rtf "Skills is important, especially technical skills. SAS support both. B/4 now, SAS supply the software to clients to implement, or SAS implement the software for clients. "	Team Skills
	Source: TFL Transcript_25022013_Copy.rtf "The initial skills for the pilot were all in-	Team Skills

	house."	
	Source: TFL Transcript_25022013_Copy.rtf " Most of these information would need to be brought in. WE now recruit a lot of graduate trainings, but they have their own ways of doing things. The old and new need to match for the future."	Team Skills Lessons Learnt
Data standard	Source: GAP Transcript_12022014_Copy.rtf "Data needs to be accurate, quality accurate data end to end."	Data Quality Data standard
	Source: ORR Translation_February_2013_Copy.rtf "Data standardisation · Data quality to be unparallel "	Data Quality Data standard BI Implementation Success
	Source: SAS Transcript_27022013_Copy.rtf "his is quality is really key, garbage in garbage out. The quality of data reflects the use of information and decision. From management perspective, data quality is top priority"	Data standard
	Source: TFL Transcript_25022013_Copy.rtf "There was no drill down on data, no clear way of defining and grouping data, old system was repetitive. Financial report could take up to 4 weeks to prepare, management thought enough was enough."	Data Challenge Data standard
	Source: TFL_Business Intelligence Implementation at TFL.txt "Facts / Measures Location Spatial / Network Model Data Model Matching Data to Reality Monitoring the impact of street works "	Data Warehouse Data standard ETL Challenge
Participating Organisation	Source: GAP Transcript_12022014_Copy.rtf "GAP plc."	Participating Organisation

	Source: ORR Translation_February_2013_Copy.rtf "Office of the Railway Regulator (ORR)"	Participating Organisation
	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Safety authority for rail industry Economic regulator for mainline railway Set Network Rail and HS1's outputs and funding Monitor progress against delivery plan Evidence-base for investigations and prosecutions Hold the industry to account Maintain high safety standards Support passengers and consumers Produce and disseminate official statistics "	Industry Participating Organisation
	Source: SAS Transcript_27022013_Copy.rtf "Organisation: SAS (Statistical Analysis Software) Plc"	Participating Organisation
	Source: TFL Transcript_25022013_Copy.rtf "Transport for London (TFL) Directorate of Traffic"	Participating Organisation
Software functionalities	Source: SAS Transcript_27022013_Copy.rtf "SAS system can integrate with existing client backend, e.g. CRM system, ERP SQL, Oracle etc. SAS has its own data integrator tool that helps with backend integration"	Software functionalities Software license
	Source: SAS Transcript_27022013_Copy.rtf "SAS has dada analysis tools specific to particular industry like SAS for Retail, SAS for Oil and Gas, SAS for public sector etc. And these tools has data governance and management tools pre-designed to be used by clients to comply with data governance issue in their industry. "	Software functionalities
	Source: SAS Transcript_27022013_Copy.rtf "So understanding the functionality of the application by the customer is key, and reviewing how clients use the deployment and what they plan to undertake is key"	Software functionalities Post implementation

		re-evaluation
	Source: TFL Transcript_25022013_Copy.rtf "We use Oracle BI suite purely because it integrated very well with the GIS database system that was already in place. "	Software Selection Software support Software functionalities
Post implementation re-evaluation	Source: SAS Transcript_27022013_Copy.rtf "Noted re-evaluation of deployment seems to be something that is not normally undertaken. Described it as project review stage. Noted that it is paramount to revisits how clients are using the system, and what other benefits they expect from the system. Re-evaluation is not something that is often really done or well done. More of follow up after implementation should be done. "	Post implementation re-evaluation
	Source: SAS Transcript_27022013_Copy.rtf "It is important that the BI solution is constantly reviewed. Sometimes, the client come with a particular challenge which is implemented, but he may not be aware of other capability of the software, and may and perhaps implement another system when faced with another or different challenge. F"	Post implementation re-evaluation
	Source: SAS Transcript_27022013_Copy.rtf "So understanding the functionality of the application by the customer is key, and reviewing how clients use the deployment and what they plan to undertake is key"	Software functionalities Post implementation re-evaluation
	Source: SAS Transcript_27022013_Copy.rtf "Noted that SAS has a pre-initiative questionnaire, which are normally sent to client to fill out and indicate what they want from the solution on offer, and perhaps they might plan t to o do in future. However, he noted that the questionnaire are in pre-selected	Post implementation re-evaluation

	options, and clients may not have adequate option to write or describe further details. "	
Technical Infrastructure	Source: ORR Translation_February_2013_Copy.rtf "Externally hosted. There was a battle with our internal IT Manager who wanted it to be hosted internally, but we opted for external hosting for scalability that it could provide and we pay monthly hosting and support fee"	Technical Infrastructure
	Source: SAS Transcript_27022013_Copy.rtf "Adequate resourcing is key. The client must be able to provide the right resources who understand where data is, and understand some of their business processes. Adequate resourcing is also helpful in providing the right technical skills and developers."	Adequate Budget Technical Infrastructure
	Source: SAS Transcript_27022013_Copy.rtf "The technical infrastructure in terms of storage, networks, hardware etc must be adequate and scalable to support the implementation and for future expansion. "	Technical Infrastructure Storage Area Network (SAN)
	Source: SAS Transcript_27022013_Copy.rtf "Not so much of an issue with SAS, SAS could be deployed under any technical infrastructure, wither windows or UNIX, or Microsoft database or Oracle or other 3rd party database backend"	Technical Infrastructure
External consultants	Source: ORR Translation_February_2013_Copy.rtf "we commissioned (AMOR), a third party company to access best practice with respect to our business intelligence"	External consultants
	Source: ORR Translation_February_2013_Copy.rtf "IMGGroup who developed the data warehouse"	Data Warehouse External consultants
	Source: ORR	External

	Translation_February_2013_Copy.rtf " Because of the criticality of the system and the portal reports, accessed by the public, we wanted that uninterrupted service, which we thought could most probably be provided by third party services and hosting company. "	consultants
	Source: SAS Transcript_27022013_Copy.rtf "Example of such partners are 3rd party companies like Accenture, Atos, Cap Gemini and others. Some of these 3rd party organisations have pool of developers and experience with the software which is good. SAS could work directly with clients, or through the 3rd party partners or IT Services companies to implement. "	External consultants
User Training	Source: GAP Transcript_12022014_Copy.rtf "The best approach is to create tools that are intuitive, so that you do not have to train all the time"	User Training User Intuition
	Source: ORR Translation_February_2013_Copy.rtf "In the beginning, we got the staffs who would be affected on a Warehouse\Business Intelligence Fundamental Training, with an external person, to give some knowledge about "	User Training
	Source: SAS Transcript_27022013_Copy.rtf "SAS provide onsite support and training. User training is important and the earlier users are trained to utilise the system the better. With SAS system, training had greatly improved, and SAS can deliver one day end user training which helps to shorten project life cycle. "	User Training
	Source: TFL Transcript_25022013_Copy.rtf "We undertook training, it was in house"	User Training
Software support	Source: GAP Transcript_12022014_Copy.rtf "We chose MicroStrategy because it had the	Software support

	Microsoft Office Addition like Excel which some of the staff is familiar with in using. "	
	Source: SAS Transcript_27022013_Copy.rtf "Depending on project, but one software suite is better and easier to implement successfully. Indicated data some of the data integration tools might do things differently, for example they might represent data differently, or use a vale differently. There is also the issue of skills, having multiple software skills to implement different aspect of the software, in the project."	Software support
	Source: SAS Transcript_27022013_Copy.rtf "The benefit of using the package software is, if you have to upgrade, you do it once across all tools, and SAS will supply the latest version of the software, most of the time at no extra cost as long as they pay their yearly software renewal fee. If you mix and match tools in the implementation, then you have multiple and difference upgrades to make and at different times, which could be disrupting"	Software support Software Selection
	Source: TFL Transcript_25022013_Copy.rtf "We use Oracle BI suite purely because it integrated very well with the GIS database system that was already in place. "	Software Selection Software support Software functionalities
Implementation Methodology	Source: GAP Transcript_12022014_Copy.rtf "perhaps one would need a good project management framework to guide the process such as Kimball methodology. "	Implementation Methodology
	Source: GAP Transcript_12022014_Copy.rtf "used an agile implementation approach. "	Agile Development Implementation Methodology

	Source: SAS Transcript_27022013_Copy.rtf "SAS a process of agile deployment. That means deploying the solution in stages, ready to be used until the whole delivery is complete"	Agile Development Implementation Methodology
	Source: TFL Transcript_25022013_Copy.rtf "Technically, we had separate system for development, UAT and production, and so we could separate development work, we could separate versions"	Implementation Methodology
ETL Challenge	Source: GAP Transcript_12022014_Copy.rtf "The real key understands the source data, and knows that the sourced data is trusty."	ETL Challenge
	Source: SAS Transcript_27022013_Copy.rtf "Now, SAS has developed into a solution company now supplying data integration tool, analysis and reporting, and SAS now provide this end-to-end solution. However, companies can buy one of SAS tool, and combine it to develop their own custom software solution. "	ETL Challenge
	Source: TFL_Business Intelligence Implementation at TFL.txt "Data Hub Data Hub Processes Landing Area Data Feeds Raw Data Transformation and Alignment Aggregation Business Rules "	Data Warehouse ETL Challenge
	Source: TFL_Business Intelligence Implementation at TFL.txt "Facts / Measures Location Spatial / Network Model Data Model Matching Data to Reality Monitoring the impact of street works "	Data Warehouse Data standard ETL Challenge
Technical Platform	Source: GAP Transcript_12022014_Copy.rtf "We built our business intelligence system on data warehouse backend platform."	Data Warehouse Technical Platform
	Source: GAP Transcript_12022014_Copy.rtf	Technical

	"Our data warehouse is about 5 terabyte. We have Cognos Reporting, Microstrategy,"	Platform
	Source: ORR Translation_February_2013_Copy.rtf " Microsoft SQL Server Platform, with SSRS, SSIS"	Technical Platform
	Source: TFL Transcript_25022013_Copy.rtf " We use Oracle BI suite "	Technical Platform
Business side sponsor	Source: TFL Transcript_25022013_Copy.rtf "Who drove the BI initiative, IT or business? In this implementation, business drove it rather than IT"	Business side sponsor
	Source: TFL Transcript_25022013_Copy.rtf "I worked with an analysts from the business side, in developing it, and I came from IT, so we overlap each other."	Business side sponsor
	Source: TFL Transcript_25022013_Copy.rtf "Sometimes, there is constant fighting between IT and business, now we have a BI uniting IT. They provide hep with project planning, IT infrastructure, thy provide assistance with data governance and new BI initiative. For this project, the BI was with the business rather than IT. There was a BI project delivered by IT in the past that did not meet up with expectation, mainly because it was more driven by IT. "	BI Business Alignment Business side sponsor Clear Business Case
Executive Level BI champion	Source: SAS Transcript_27022013_Copy.rtf "Executive Sponsor or Champion is very key. Somebody that will own the BI project at the client or business end, that will be the main point of contact from the supply perspective or IT implementation"	Executive Sponsor Executive Level BI champion Lessons Learnt
	Source: SAS Transcript_27022013_Copy.rtf "Where this lacking, multiple authorities and	Executive Level BI champion

	authorisation come in, which can cripple the BI project."	
	Source: TFL Transcript_25022013_Copy.rtf "Get High level support initially. Without high level support and clear business case, you do not stand a chance."	Executive Level BI champion Management Support Lessons Learnt
Clear project scope	Source: SAS Transcript_27022013_Copy.rtf "Clients and implementers most clearly define the functionality expectations, to avoid PR creep"	Clear project scope Clear Business Case Project Management
	Source: TFL Transcript_25022013_Copy.rtf "Define business requirement clearly. Business forget how it was before and what they want changes constantly"	Lessons Learnt Clear project scope
	Source: TFL Transcript_25022013_Copy.rtf "Be honest in terms of what could be delivered. Honest in accuracy of data and delivery of data. Data accuracy is key, work with data owners, data owners remain data owners"	Clear project scope Communication
Communication	Source: ORR Translation_February_2013_Copy.rtf "Communication is key and have to be consistent, with internal stakeholders and the third party implementing the data warehouse, it has to be consistent. We also have to work with our external affairs directorate, that help with communication with the external developing organisation, setting up meetings, communicating agreement both ways etc. "	Communication
	Source: SAS Transcript_27022013_Copy.rtf	Communication

	"Communication is very critical to any project. There should be "a clear point of contact and having a strong and structured communication process was crucial for success. "	Communication method
	Source: TFL Transcript_25022013_Copy.rtf "Be honest in terms of what could be delivered. Honest in accuracy of data and delivery of data. Data accuracy is key, work with data owners, data owners remain data owners"	Clear project scope Communication
PRINCE2	Source: ORR Translation_February_2013_Copy.rtf "We use PRINCE2 approach for the data warehouse. There was a clear project implementation schedules and planning managed by a dedicated project manager who."	Project Management PRINCE2 Regular Management update
	Source: SAS Transcript_27022013_Copy.rtf "SAS has a PM for every project and SAS PM Stay and work at client site, attending their meetings and passing communication through and fro. SAS PM are PRINCE2 qualified"	Project Management PRINCE2
	Source: TFL Transcript_25022013_Copy.rtf "We had a PM, he was PRINCE2."	PRINCE2
Data providing organisation	Source: ORR Translation_February_2013_Copy.rtf ""more than 95% of data that came from the various railway data providing organisations DPOs data came from Network rail, virgin, LUL, and other 30-40 organisation, do provide data."	Data providing organisation
	Source: ORR Translation_February_2013_Copy.rtf ""Railway Statistics Management Group", it is a kind of industry governance group established since 1966. We used this group top push through the data required. "	Data providing organisation

	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "MOU's with data providing organisations (DPO): Format and content of data Timeliness of provision Governance and contact points "	Data providing organisation
User Participation	Source: GAP Transcript_12022014_Copy.rtf "The business owner and users should drive the BI project,"	User Participation
	Source: ORR Translation_February_2013_Copy.rtf "We got them involved in developing it, things like developing the report taxonomies, i.e. how the reports from the BI should look like, assisting with developing the UAT scripts"	UAT (User Acceptance Testing) User feedback User Participation
	Source: SAS Transcript_27022013_Copy.rtf "One of the things SAS does is to bring together about 3 or so experience users who also might be management position to get involved in the initial scoping of the requirements of the system in terms of quality they might consider more important "	User Participation
Scorecards, Dashboard KPIs	Source: GAP Transcript_12022014_Copy.rtf "Scorecard, Dashboards, and Key Performance Indicators KPIs."	Scorecards, Dashboard KPIs
	Source: TFL_Business Intelligence Implementation at TFL.txt "Stars and lookups available for query Data Modelling "	Scorecards, Dashboard KPIs
	Source: TFL_Business Intelligence Implementation at TFL.txt "Shared Common Calendar Shared Common Location Data snapped to Calendar and Location during ETL process. System Data "	Scorecards, Dashboard KPIs Reporting Tools BI Challenge

Meta data modelling	Source: GAP Transcript_12022014_Copy.rtf "master data, also called Meta data,"	Meta data modelling
	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Master package Warehouse package Data warehouse Report Builder Data Portal website "	Data Warehouse Meta data modelling
	Source: TFL Transcript_25022013_Copy.rtf "Meta data analysis,"	Meta data modelling Data Challenge
Reporting Tools	Source: GAP Transcript_12022014_Copy.rtf " Cognos Reporting, Microstrategy, SQL Estart, Business Systems tools, other departmental reporting tools."	Reporting Tools BI Challenge
	Source: GAP Transcript_12022014_Copy.rtf "To consolidate multiple data reporting tools, reduce software licensing and administration and importantly have an end-to-end view of the buying and retailing (merchandising) process."	Why BI Software license Reporting Tools
	Source: TFL_Business Intelligence Implementation at TFL.txt "Shared Common Calendar Shared Common Location Data snapped to Calendar and Location during ETL process. System Data "	Scorecards, Dashboard KPIs Reporting Tools BI Challenge
Data warehouse size	Source: GAP Transcript_12022014_Copy.rtf "warehouse is about 5 terabyte."	Data warehouse size
	Source: ORR Translation_February_2013_Copy.rtf "There is also a combination of ASP.net. The data warehouse is about 500GB"	Data warehouse size

	Source: TFL Transcript_25022013_Copy.rtf "Total database size about 2 terabyte"	Data warehouse size
Transport for London TFL	Source: TFL Transcript_25022013_Copy.rtf "Transport for London (TFL)"	Transport for London TFL
	Source: TFL_Business Intelligence Implementation at TFL.txt "intelligent Traffic Systems "	Transport Industry Transport for London TFL
Nature of Organisation	Source: SAS Transcript_27022013_Copy.rtf "Organisation size and structure could be a factor. Sometimes, the larger the organisation, the longer it takes to deliver the project. Bigger organisations, has established processes for procurement, change control, project management etc"	Nature of Organisation Organisation size and sector
	Source: TFL Transcript_25022013_Copy.rtf "Also in TFL there was a lot of data, and we were really concerned with the issue of data accuracy Data accuracy is key, work with data owners, on data accuracy, data owners remain data owners. Traffic incident management system, major data source for the BI system GIS data was also integrated onto the system "	Data Challenge Nature of Organisation
Consistent Communication	Source: ORR Translation_February_2013_Copy.rtf "Communication should be consistent and get advice from people. We also used; "	Consistent Communication
	Source: SAS Transcript_27022013_Copy.rtf "Where change and expectations are not well managed, this is where things go wrong most times"	Consistent Communication Managing Change
UAT (User Acceptance Testing)	Source: ORR Translation_February_2013_Copy.rtf	UAT (User Acceptance Testing)

	"We got them involved in developing it, things like developing the report taxonomies, i.e. how the reports from the BI should look like, assisting with developing the UAT scripts"	User feedback User Participation
	Source: ORR Translation_February_2013_Copy.rtf "Most challenging is testing. Test a lot in UAT. If you do not get thorough with testing, and "	UAT (User Acceptance Testing)
BI Business Alignment	Source: ORR Translation_February_2013_Copy.rtf "n our case, by introducing the BI we made 4 people surplus or redundant. There were 3 groups_ pf people whose job was to receive these reports from the DPOs and input them manually into a system"	BI Business Alignment
	Source: TFL Transcript_25022013_Copy.rtf "Sometimes, there is constant fighting between IT and business, now we have a BI uniting IT. They provide hep with project planning, IT infrastructure, thy provide assistance with data governance and new BI initiative. For this project, the BI was with the business rather than IT. There was a BI project delivered by IT in the past that did not meet up with expectation, mainly because it was more driven by IT. "	BI Business Alignment Business side sponsor Clear Business Case
Lenght of project	Source: ORR Translation_February_2013_Copy.rtf "Restructuring started in 2009. Started building the warehouse in Sept 2009, and launched it in April 2010 (six months approximate)"	Length of project

	Source: SAS Transcript_27022013_Copy.rtf "Noted the SAS software itself can be delayed in a day. But depending on the size of the project or deployment, and as indicated all the resources required hardware, etc SAS deployment can take up to 2 years. "	Lenght of project
Transport Industry	Source: ORR Translation_February_2013_Copy.rtf "Transport, Railways "	Transport Industry
	Source: TFL_Business Intelligence Implementation at TFL.txt "intelligent Traffic Systems "	Transport Industry Transport for London TFL
Railways	Source: ORR Translation_February_2013_Copy.rtf "Transport, Railways"	Railways
	Source: TFL Transcript_25022013_Copy.rtf "Transport, Railways"	Railways
Office of Railway Regulator	Source: ORR Translation_February_2013_Copy.rtf "Office of the Railway Regulator"	Office of Railway Regulator
	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Office of Rail Regulation"	Office of Railway Regulator
Software license	Source: GAP Transcript_12022014_Copy.rtf "To consolidate multiple data reporting tools, reduce software licensing and administration and importantly have an end-to-end view of the buying and retailing (merchandising) process."	Why BI Software license Reporting Tools
	Source: SAS Transcript_27022013_Copy.rtf	Software functionalities

	"SAS system can integrate with existing client backend, e.g. CRM system, ERP SQL, Oracle etc. SAS has its own data integrator tool that helps with backend integration"	Software license
BI activism	Source: GAP Transcript_12022014_Copy.rtf "Also, you need a business intelligence advocate who becomes trainees of their own area. "	BI activism
	Source: GAP Transcript_12022014_Copy.rtf "They create a whole lot of expertise and then train others. These are the business intelligence data stewards who make sure the data are updated, correct, and reliable"	BI activism BI Competency Centre
User Intuition	Source: GAP Transcript_12022014_Copy.rtf "The best approach is to create tools that are intuitive, so that you do not have to train all the time"	User Training User Intuition
	Source: SAS Transcript_27022013_Copy.rtf "Not really, unlike ten years ago. Most of the underling SQL have now been embedded in SAS and all users need is to be able to drag and drop. But they must be trained on how to utilise the system and understand their data. SAS can do one day training."	Technical Skills User Intuition
Agile Development	Source: GAP Transcript_12022014_Copy.rtf "used an agile implementation approach. "	Agile Development Implementation Methodology
	Source: SAS Transcript_27022013_Copy.rtf "SAS a process of agile deployment. That means deploying the solution in stages, ready to be used until the whole delivery is complete"	Agile Development Implementation Methodology
Industry	Source: GAP Transcript_12022014_Copy.rtf "Commerce-Fashion Retailer "	Industry

	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Safety authority for rail industry Economic regulator for mainline railway Set Network Rail and HS1's outputs and funding Monitor progress against delivery plan Evidence-base for investigations and prosecutions Hold the industry to account Maintain high safety standards Support passengers and consumers Produce and disseminate official statistics "	Industry Participating Organisation
Commerce	Source: GAP Transcript_12022014_Copy.rtf "Commerce-Fashion Retailer"	Commerce
	Source: SAS Transcript_27022013_Copy.rtf "Commercial - Independent Software Vendor ISV"	Commerce
Knowledge transfer	Source: TFL Transcript_25022013_Copy.rtf " In house training is very important. Identify key users knowledgeable about the (a) data and (b) system. Started bringing these people in to get trained. They were trained to train other users. They were involved in the very initial setup. "	Knowledge transfer
Organisation size and sector	Source: SAS Transcript_27022013_Copy.rtf "Organisation size and structure could be a factor. Sometimes, the larger the organisation, the longer it takes to deliver the project. Bigger organisations, has established processes for procurement, change control, project management etc"	Nature of Organisation Organisation size and sector
Realistic schedules	Source: SAS Transcript_27022013_Copy.rtf "Now the issue is, they might expect that the new request is part of the existing charge. Of course, it might be a minor request or change, that might not be coasted or c hared. But there might be other situation that are chargeable and requires the client to pick up the bills. So it is important that the scope is well defined and agreed, and an additional to agreed delivery is signed off "	Project Management Realistic schedules

Storage Area Network (SAN)	Source: SAS Transcript_27022013_Copy.rtf "The technical infrastructure in terms of storage, networks, hardware etc must be adequate and scalable to support the implementation and for future expansion. "	Technical Infrastructure Storage Area Network (SAN)
Technical Skills	Source: SAS Transcript_27022013_Copy.rtf "Not really, unlike ten years ago. Most of the underling SQL have now been embedded in SAS and all users need is to be able to drag and drop. But they must be trained on how to utilise the system and understand their data. SAS can do one day training."	Technical Skills User Intuition
Adequate Budget	Source: SAS Transcript_27022013_Copy.rtf "Adequate resourcing is key. The client must be able to provide the right resources who understand where data is, and understand some of their business processes. Adequate resourcing is also helpful in providing the right technical skills and developers."	Adequate Budget Technical Infrastructure
Cross departmental communication	Source: SAS Transcript_27022013_Copy.rtf "Communication is key and there should be somebody that can comminute the technical issues to business, and the business issues to the IT people. The IT people who implement these system, might have little knowledge of the business processes of these organisations"	Cross departmental communication
Process Related Factors	Source: SAS Transcript_27022013_Copy.rtf "Project planning is key, SAS has all its PM working at client sites, to help with communicating business requirement to IT team, undertaking resourcing and monitoring project delivery. SAS has a PM for every project and SAS PM Stay and work at client site, attending their meetings and passing communication through and fro. SAS PM are PRINCE2 qualified. SAS cam work with any PM methodology of the organisation, although SAS has their own PM methodology. For small involvement, PM methodology might not be necessary, but it does help for communication, planning and resourcing. PM is very good and necessary especially for big	Process Related Factors

	project."	
SAS Plc.	Source: SAS Transcript_27022013_Copy.rtf " SAS (Statistical Analysis Software) Plc"	SAS Plc.
User feedback	Source: ORR Translation_February_2013_Copy.rtf "We got them involved in developing it, things like developing the report taxonomies, i.e. how the reports from the BI should look like, assisting with developing the UAT scripts"	UAT (User Acceptance Testing) User feedback User Participation
Team meetings	Source: ORR Translation_February_2013_Copy.rtf "Our PM organises and does the planning. We have checkpoint meetings, project board meetings, all governed by our won in house transparency managers. IMGGroup who developed the data warehouse would have had their own methodology."	Team meetings Project Management
Regular Management update	Source: ORR Translation_February_2013_Copy.rtf "We use PRINCE2 approach for the data warehouse. There was a clear project implementation schedules and planning managed by a dedicated project manager who."	Project Management PRINCE2 Regular Management update
Net Present Value (NPV)	Source: ORR Translation_February_2013_Copy.rtf "We did full cost benefit analysis, and did full business case including Net Present value NPV"	Clear Business Case Net Present Value (NPV)
BI Competency Centre	Source: GAP Transcript_12022014_Copy.rtf "They create a whole lot of expertise and then train others. These are the business intelligence data stewards who make sure the data are updated, correct, and reliable"	BI activism BI Competency Centre

Team coordination	Source: GAP Transcript_12022014_Copy.rtf "Generally, we wrap up most of the work and send it to the United States to deliver. Gap implementation strategy is to be a global brand. "	Team coordination
Facts and Dimension Table	Source: GAP Transcript_12022014_Copy.rtf "We built a data ware house structure based on fact and dimension table"	Facts and Dimension Table
Gap Plc.	Source: GAP Transcript_12022014_Copy.rtf " GAP plc."	Gap Plc.

Appendix 21: Code Pairs and Segment Frequency

Code Pair	Segment(s)	Segment Code(s)
Lessons Learnt + Executive Level BI champion	Source: SAS Transcript_27022013_Copy.rtf "Executive Sponsor or Champion is very key. Somebody that will own the BI project at the client or business end, that will be the main point of contact from the supply perspective or IT implementation"	Executive Sponsor Executive Level BI champion Lessons Learnt
	Source: TFL Transcript_25022013_Copy.rtf "Get High level support initially. Without high level support and clear business case, you do not stand a chance."	Executive Level BI champion Management Support

		Lessons Learnt
Software Selection + Software support	Source: SAS Transcript_27022013_Copy.rtf "The benefit of using the package software is, if you have to upgrade, you do it once across all tools, and SAS will supply the latest version of the software, most of the time at no extra cost as long as they pay their yearly software renewal fee. If you mix and match tools in the implementation, then you have multiple and difference upgrades to make and at different times, which could be disrupting"	Software support Software Selection
	Source: TFL Transcript_25022013_Copy.rtf "We use Oracle BI suite purely because it integrated very well with the GIS database system that was already in place. "	Software Selection Software support Software functionalities
Implementation Methodology + Agile Development	Source: GAP Transcript_12022014_Copy.rtf "used an agile implementation approach. "	Agile Development Implementation Methodology
	Source: SAS Transcript_27022013_Copy.rtf "SAS a process of agile deployment. That means deploying the solution in stages, ready to be used until the whole delivery is complete"	Agile Development Implementation Methodology
Project Management + PRINCE2	Source: ORR Translation_February_2013_Copy.rtf "We use PRINCE2 approach for the data warehouse. There was a clear project implementation schedules and planning	Project Management PRINCE2 Regular

	managed by a dedicated project manager who."	Management update
	Source: SAS Transcript_27022013_Copy.rtf "SAS has a PM for every project and SAS PM Stay and work at client site, attending their meetings and passing communication through and fro. SAS PM are PRINCE2 qualified"	Project Management PRINCE2
Executive Sponsor + Lessons Learnt	Source: SAS Transcript_27022013_Copy.rtf "Executive Sponsor or Champion is very key. Somebody that will own the BI project at the client or business end, that will be the main point of contact from the supply perspective or IT implementation"	Executive Sponsor Executive Level BI champion Lessons Learnt
	Source: TFL_Business Intelligence Implementation at TFL.txt "Identify champions early on "	Lessons Learnt Executive Sponsor
Data Quality + Data standard	Source: GAP Transcript_12022014_Copy.rtf "Data needs to be accurate, quality accurate data end to end."	Data Quality Data standard
	Source: ORR Translation_February_2013_Copy.rtf "Data standardisation · Data quality to be unparalleled "	Data Quality Data standard BI Implementation Success
Data Warehouse + ETL Challenge	Source: TFL_Business Intelligence Implementation at TFL.txt "Data Hub Data Hub Processes Landing Area Data Feeds Raw Data Transformation and	Data Warehouse ETL Challenge

	Alignment Aggregation Business Rules "	
	Source: TFL_Business Intelligence Implementation at TFL.txt "Facts / Measures Location Spatial / Network Model Data Model Matching Data to Reality Monitoring the impact of street works "	Data Warehouse Data standard ETL Challenge
Why BI + Data Challenge	Source: ORR Translation_February_2013_Copy.rtf "Before now as far back as 2009, the ORR was a like typical company, with data silos everywhere, using excel and Microsoft Access to access database. Much of data management process were manual, time consuming and offered limited business insight. There were no common data quality standards and processes, and no data sharing protocols in place "	Why BI Data Challenge
	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt " Disparate data management or analysis function Numerous and primitive 'databases' No defined processes or succession planning Inconsistent and duplicated data "	Data Challenge Why BI
BI Challenge + Reporting Tools	Source: GAP Transcript_12022014_Copy.rtf " Cognos Reporting, Microstrategy, SQL Server, Business Systems tools, other departmental reporting tools."	Reporting Tools BI Challenge
	Source: TFL_Business Intelligence Implementation at TFL.txt "Shared Common Calendar Shared Common Location Data snapped to Calendar and Location during ETL process. System Data "	Scorecards, Dashboard KPIs Reporting Tools BI Challenge

Nature of Organisation + Organisation size and sector	Source: SAS Transcript_27022013_Copy.rtf "Organisation size and structure could be a factor. Sometimes, the larger the organisation, the longer it takes to deliver the project. Bigger organisations, has established processes for procurement, change control, project management etc"	Nature of Organisation Organisation size and sector
Post implementation re-evaluation + Software functionalities	Source: SAS Transcript_27022013_Copy.rtf "So understanding the functionality of the application by the customer is key, and reviewing how clients use the deployment and what they plan to undertake is key"	Software functionalities Post implementation re-evaluation
Technical Infrastructure + Storage Area Network (SAN)	Source: SAS Transcript_27022013_Copy.rtf "The technical infrastructure in terms of storage, networks, hardware etc must be adequate and scalable to support the implementation and for future expansion. "	Technical Infrastructure Storage Area Network (SAN)
Technical Infrastructure + Adequate Budget	Source: SAS Transcript_27022013_Copy.rtf "Adequate resourcing is key. The client must be able to provide the right resources who understand where data is, and understand some of their business processes. Adequate resourcing is also helpful in providing the right technical skills and developers."	Adequate Budget Technical Infrastructure
Communication + Clear project scope	Source: TFL Transcript_25022013_Copy.rtf "Be honest in terms of what could be delivered. Honest in accuracy of data and delivery of data. Data accuracy is key, work with data owners, data owners remain data owners"	Clear project scope Communication
Communication + Communication method	Source: SAS Transcript_27022013_Copy.rtf "Communication is very critical to any project. There should be "a clear point of contact and having a strong and structured communication process was crucial for success. "	Communication Communication method
UAT (User Acceptance	Source: ORR Translation_February_2013_Copy.rtf	UAT (User Acceptance

Testing) + User feedback	"We got them involved in developing it, things like developing the report taxonomies, i.e. how the reports from the BI should look like, assisting with developing the UAT scripts"	Testing) User feedback User Participation
Management Support + Executive Level BI champion	Source: TFL Transcript_25022013_Copy.rtf "Get High level support initially. Without high level support and clear business case, you do not stand a chance."	Executive Level BI champion Management Support Lessons Learnt
PRINCE2 + Regular Management update	Source: ORR Translation_February_2013_Copy.rtf "We use PRINCE2 approach for the data warehouse. There was a clear project implementation schedules and planning managed by a dedicated project manager who."	Project Management PRINCE2 Regular Management update
BI Business Alignment + Business side sponsor	Source: TFL Transcript_25022013_Copy.rtf "Sometimes, there is constant fighting between IT and business, now we have a BI uniting IT. They provide hep with project planning, IT infrastructure, thy provide assistance with data governance and new BI initiative. For this project, the BI was with the business rather than IT. There was a BI project delivered by IT in the past that did not meet up with expectation, mainly because it was more driven by IT. "	BI Business Alignment Business side sponsor Clear Business Case
BI Benefit + BI Implementation Success	Source: ORR Translation_February_2013_Copy.rtf "More professionalism in reporting. For example, our inspectors request information, we want to create it in an hour rather than weeks, in the past. · Now that we have got all these, they want more. · BI make data very visible, can do more with data, which is goo"	BI Benefit BI Implementation Success

Transport Industry + Transport for London TFL	Source: TFL_Business Intelligence Implementation at TFL.txt "intelligent Traffic Systems "	Transport Industry Transport for London TFL
Software license + Software functionalities	Source: SAS Transcript_27022013_Copy.rtf "SAS system can integrate with existing client backend, e.g. CRM system, ERP SQL, Oracle etc. SAS has its own data integrator tool that helps with backend integration"	Software functionalities Software license
Lessons Learnt + Clear project scope	Source: TFL Transcript_25022013_Copy.rtf "Define business requirement clearly. Business forget how it was before and what they want changes constantly"	Lessons Learnt Clear project scope
Lessons Learnt + Management Support	Source: TFL Transcript_25022013_Copy.rtf "Get High level support initially. Without high level support and clear business case, you do not stand a chance."	Executive Level BI champion Management Support Lessons Learnt
BI activism + BI Competency Centre	Source: GAP Transcript_12022014_Copy.rtf "They create a whole lot of expertise and then train others. These are the business intelligence data stewards who make sure the data are updated, correct, and reliable"	BI activism BI Competency Centre
User Intuition + Technical Skills	Source: SAS Transcript_27022013_Copy.rtf "Not really, unlike ten years ago. Most of the underling SQL have now been embedded in SAS and all users need is to be able to drag and drop. But they must be trained on how to utilise the system and understand their data. SAS can do one day training."	Technical Skills User Intuition
User Training + User Intuition	Source: GAP Transcript_12022014_Copy.rtf "The best approach is to create tools that are intuitive, so that you do not have to train all the	User Training User Intuition

	time"	
User Participation + User feedback	Source: ORR Translation_February_2013_Copy.rtf "We got them involved in developing it, things like developing the report taxonomies, i.e. how the reports from the BI should look like, assisting with developing the UAT scripts"	UAT (User Acceptance Testing) User feedback User Participation
User Participation + UAT (User Acceptance Testing)	Source: ORR Translation_February_2013_Copy.rtf "We got them involved in developing it, things like developing the report taxonomies, i.e. how the reports from the BI should look like, assisting with developing the UAT scripts"	UAT (User Acceptance Testing) User feedback User Participation
Managing Change + Consistent Communication	Source: SAS Transcript_27022013_Copy.rtf "Where change and expectations are not well managed, this is where things go wrong most times"	Consistent Communication Managing Change
Software support + Software functionalities	Source: TFL Transcript_25022013_Copy.rtf "We use Oracle BI suite purely because it integrated very well with the GIS database system that was already in place. "	Software Selection Software support Software functionalities
Software Selection + Software functionalities	Source: TFL Transcript_25022013_Copy.rtf "We use Oracle BI suite purely because it integrated very well with the GIS database system that was already in place. "	Software Selection Software support Software functionalities
Software Selection	Source: GAP Transcript_12022014_Copy.rtf	Proof of

+ Proof of concept	"f you want users to have self service, what does that mean? You want mobile business intelligence what does that mean, and at what cost. You want a Wi-Fi enabled in your business intelligence system, b then how does it work with the chosen software? All these must be demonstrated first before you plug in to particular software. "	concept Software Selection
Team Skills + Lessons Learnt	Source: TFL Transcript_25022013_Copy.rtf " Most of these information would need to be brought in. WE now recruit a lot of graduate trainings, but they have their own ways of doing things. The old and new need to match for the future."	Team Skills Lessons Learnt
Project Management + Clear project scope	Source: SAS Transcript_27022013_Copy.rtf "Clients and implementers most clearly define the functionality expectations, to avoid PR creep"	Clear project scope Clear Business Case Project Management
Project Management + Realistic schedules	Source: SAS Transcript_27022013_Copy.rtf "Now the issue is, they might expect that the new request is part of the existing charge. Of course, it might be a minor request or change, that might not be coasted or c hared. But there might be other situation that are chargeable and requires the client to pick up the bills. So it is important that the scope is well defined and agreed, and an additional to agreed delivery is signed off "	Project Management Realistic schedules
Project Management + Team meetings	Source: ORR Translation_February_2013_Copy.rtf "Our PM organises and does the planning. We have checkpoint meetings, project board meetings, all governed by our won in house transparency managers. IMGGroup who developed the data warehouse would have had their own methodology."	Team meetings Project Management

Project Management + Regular Management update	Source: ORR Translation_February_2013_Copy.rtf "We use PRINCE2 approach for the data warehouse. There was a clear project implementation schedules and planning managed by a dedicated project manager who."	Project Management PRINCE2 Regular Management update
Executive Sponsor + Executive Level BI champion	Source: SAS Transcript_27022013_Copy.rtf "Executive Sponsor or Champion is very key. Somebody that will own the BI project at the client or business end, that will be the main point of contact from the supply perspective or IT implementation"	Executive Sponsor Executive Level BI champion Lessons Learnt
Executive Sponsor + Management Support	Source: ORR Translation_February_2013_Copy.rtf "This is railway and we do some dull stuff. To galvanise interest in the project, we got we wanted and who got clout on the project board. They help to spread interest at the directorate level"	Executive Sponsor Management Support
Clear Business Case + Business side sponsor	Source: TFL Transcript_25022013_Copy.rtf "Sometimes, there is constant fighting between IT and business, now we have a BI uniting IT. They provide hep with project planning, IT infrastructure, thy provide assistance with data governance and new BI initiative. For this project, the BI was with the business rather than IT. There was a BI project delivered by IT in the past that did not meet up with expectation, mainly because it was more driven by IT. "	BI Business Alignment Business side sponsor Clear Business Case
Clear Business Case + Clear project scope	Source: SAS Transcript_27022013_Copy.rtf "Clients and implementers most clearly define the functionality expectations, to avoid PR creep"	Clear project scope Clear Business Case Project Management

Clear Business Case + BI Business Alignment	Source: TFL Transcript_25022013_Copy.rtf "Sometimes, there is constant fighting between IT and business, now we have a BI uniting IT. They provide hep with project planning, IT infrastructure, thy provide assistance with data governance and new BI initiative. For this project, the BI was with the business rather than IT. There was a BI project delivered by IT in the past that did not meet up with expectation, mainly because it was more driven by IT. "	BI Business Alignment Business side sponsor Clear Business Case
Clear Business Case + Net Present Value (NPV)	Source: ORR Translation_February_2013_Copy.rtf "We did full cost benefit analysis, and did full business case including Net Present value NPV"	Clear Business Case Net Present Value (NPV)
Clear Business Case + Lessons Learnt	Source: ORR Translation_February_2013_Copy.rtf "If you cannot get the business case sorted out, if you cannot really articulate what benefit the BI will bring to the organisation, then you probably do not need it"	Clear Business Case Lessons Learnt
Clear Business Case + Project Management	Source: SAS Transcript_27022013_Copy.rtf "Clients and implementers most clearly define the functionality expectations, to avoid PR creep"	Clear project scope Clear Business Case Project Management
Data standard + BI Implementation Success	Source: ORR Translation_February_2013_Copy.rtf "Data standardisation · Data quality to be unparalleled "	Data Quality Data standard BI Implementation Success
Data standard + ETL Challenge	Source: TFL_Business Intelligence Implementation at TFL.txt "Facts / Measures Location Spatial / Network	Data Warehouse Data standard

	Model Data Model Matching Data to Reality Monitoring the impact of street works "	ETL Challenge
Data Quality + BI Implementation Success	Source: ORR Translation_February_2013_Copy.rtf "Data standardisation · Data quality to be unparalleled "	Data Quality Data standard BI Implementation Success
Data Quality + Lessons Learnt	Source: TFL Transcript_25022013_Copy.rtf "Get to grips with data governance, data quality issues"	Lessons Learnt Data Quality
Reporting Tools + Software license	Source: GAP Transcript_12022014_Copy.rtf "To consolidate multiple data reporting tools, reduce software licensing and administration and importantly have an end-to-end view of the buying and retailing (merchandising) process."	Why BI Software license Reporting Tools
Reporting Tools + Scorecards, Dashboard KPIs	Source: TFL_Business Intelligence Implementation at TFL.txt "Shared Common Calendar Shared Common Location Data snapped to Calendar and Location during ETL process. System Data "	Scorecards, Dashboard KPIs Reporting Tools BI Challenge
Data Challenge + Nature of Organisation	Source: TFL Transcript_25022013_Copy.rtf "Also in TFL there was a lot of data, and we were really concerned with the issue of data accuracy Data accuracy is key, work with data owners, on data accuracy, data owners remain data owners. Traffic incident management system, major data source for the BI system GIS data was also integrated onto the system "	Data Challenge Nature of Organisation
Data Challenge + Data Management and Integration	Source: ORR Translation_February_2013_Copy.rtf	Data Challenge Data

	"Make data validation much better. Have series of stages in data validation process, we still have some manual interaction in the process of validation."	Management and Integration
Data Challenge + Meta data modelling	Source: TFL Transcript_25022013_Copy.rtf "Meta data analysis,"	Meta data modelling Data Challenge
Data Challenge + Data standard	Source: TFL Transcript_25022013_Copy.rtf "There was no drill down on data, no clear way of defining and grouping data, old system was repetitive. Financial report could take up to 4 weeks to prepare, management thought enough was enough."	Data Challenge Data standard
Data Warehouse + External consultants	Source: ORR Translation_February_2013_Copy.rtf "IMGGroup who developed the data warehouse"	Data Warehouse External consultants
Data Warehouse + Meta data modelling	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Master package Warehouse package Data warehouse Report Builder Data Portal website "	Data Warehouse Meta data modelling
Data Warehouse + Data standard	Source: TFL_Business Intelligence Implementation at TFL.txt "Facts / Measures Location Spatial / Network Model Data Model Matching Data to Reality Monitoring the impact of street works "	Data Warehouse Data standard ETL Challenge
Data Warehouse + Technical Platform	Source: GAP Transcript_12022014_Copy.rtf "We built our business intelligence system on data warehouse backend platform."	Data Warehouse Technical Platform
Why BI + Software license	Source: GAP Transcript_12022014_Copy.rtf	Why BI

	"To consolidate multiple data reporting tools, reduce software licensing and administration and importantly have an end-to-end view of the buying and retailing (merchandising) process."	Software license Reporting Tools
Why BI + Reporting Tools	Source: GAP Transcript_12022014_Copy.rtf "To consolidate multiple data reporting tools, reduce software licensing and administration and importantly have an end-to-end view of the buying and retailing (merchandising) process."	Why BI Software license Reporting Tools
BI Challenge + Clear Business Case	Source: SAS Transcript_27022013_Copy.rtf "The first difficulty is the justifying the Business Case in some organisation. Undertaking the return on investment (RIO) seems to be the most difficult to undertake at the initial stage. "	BI Challenge Clear Business Case
BI Challenge + Scorecards, Dashboard KPIs	Source: TFL_Business Intelligence Implementation at TFL.txt "Shared Common Calendar Shared Common Location Data snapped to Calendar and Location during ETL process. System Data "	Scorecards, Dashboard KPIs Reporting Tools BI Challenge
BI Challenge + Data Challenge	Source: TFL Transcript_25022013_Copy.rtf "We have challenges with static reports, we needed periodic changing reports. We have challenges with predictive analysis, We have lots of historic data, we wanted to be able to draw more intelligence from such data. "	BI Challenge Data Challenge
BI Challenge + Data Warehouse	Source: GAP Transcript_12022014_Copy.rtf "Data warehousing design is the most critical and challenging part accounting for about 80% of the business intelligence implementation effort."	BI Challenge Data Warehouse
BI Challenge + Why BI	Source: SAS Transcript_27022013_Copy.rtf	Why BI

	"Former systems were basically just reporting on existing data, without any form of data analysis, or correlating with data from other systems, this is the Gap BI filled. BI have evolved from DSS-MIS-EIS-BI system. While each of these does some form of what modern BI do, these former systems were basically more on specific functional area of analysis of the business. BI took it further to cross functionality, to gather or centralised functional area data for analysis, mining and reporting. So this is where BI comes in."	BI Challenge
Participating Organisation + Industry	Source: ORR_Presentation_Business Intelligence Implementation in ORR.txt "Safety authority for rail industry Economic regulator for mainline railway Set Network Rail and HS1's outputs and funding Monitor progress against delivery plan Evidence-base for investigations and prosecutions Hold the industry to account Maintain high safety standards Support passengers and consumers Produce and disseminate official statistics "	Industry Participating Organisation

Statistics obtained from the following source(s):
"GAP Transcript_12022014_Copy.rtf", "ORR Translation_February_2013_Copy.rtf", "ORR_Presentation_Business Intelligence Implementation in ORR.txt", "SAS Transcript_27022013_Copy.rtf", "TFL Transcript_25022013_Copy.rtf", "TFL_Business Intelligence Implementation at TFL.txt"