A Conceptual Model for determining the Value of Business Intelligence Systems

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A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in the Department of Information Systems, University of the Western Cape

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Keywords

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Abstract

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Business Intelligence refers to the use of Information Systems to enable raw data to be collated into information that can be reported, with the end goal of using this information to enhance the business decision-making process. Business Intelligence is enabled by making use of information that is complete, relevant, accurate, timely and accessible. There are currently a number of documented perspectives that can be used to gauge the value of Business Intelligence systems; however, from an overall business value perspective the most robust method would be to identify and analyse the most commonly identified factors that impact the value assigned to Business Intelligence Systems by a company, and the correlation of each of these factors to calculate the overall value.

The importance of deriving a conceptual model, representing the major factors identified from literature and moderated by the quantitative research conducted, lies in its enabling companies and government bodies to assess the true value addition of Business Intelligence systems, and to understand the return on investment of these systems for organisations. In doing so, companies can justify or reject any further expenditure on Business Intelligence.

The quantitative research for this thesis was conducted together with a project that was run between the University of the Western Cape and the Hochschule Neu-Ulm University of Applied Sciences in Germany. The research was conducted simultaneously across organisations in South Africa and Germany on the use of BI Systems and Corporate Performance Management. The respondents for the research were Chief Executive Officers, Chief Information Officers and Business Intelligence Managers in selected organisations.

A Direct Oblimin-factor analysis was conducted on the online survey responses. The survey was conducted on a sample of approximately 1500 Business Intelligence specialists across South Africa and Germany; and 113 responses were gathered. The factor analysis reduced the key factors identified in the literature to a few major factors, namely: Information Quality, Management and Accessibility, Information Usage, and Knowledge-sharing Culture.

Thereafter, a Structural-Equation-Modelling analysis was completed using the Partial-Least-Squares method. The results indicate that there is a strong relationship between the factor-Information Quality, Management and Accessibility, and the Value of Business Intelligence. It was found that while there was no strong impact from Information Usage and Culture, there was a strong correlation between Information Usage and Culture and Information Quality, Management and Accessibility.

The research findings are significant for academic researchers, information-technology experts, Business Intelligence specialists and Business Intelligence users. This study contributes to the body of knowledge by bringing together disparate factors that have been identified in academic journals; and assessing the relationship each has on the value of Business Intelligence, as well as the correlations that exist between these factors. From this, the final conceptual model was derived using factors that were identified and tested through the Factor Analysis and the PLS-SEM.

The following conclusions can be drawn from the research: (1) The assurance of quality information in the form of complete, accurate, relevant and timeous information that is efficiently managed is the most paramount factor to an organisation deriving value from Business Intelligence systems; (2) information accessibility is key, in order to realise the value of Business Intelligence systems in organisations; and (3) Business Intelligence systems cannot add value to an organisation if a culture of information use and sharing is absent within that organisation.

The derived model can be practically implemented as a checklist for organisations to assess Business Intelligence system investments as well as current implementations.

November 2014

Declaration

I declare that ***A Conceptual Model for determining the Value of Business Intelligence Systems*** is my own original work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been appropriately indicated and acknowledged as complete references.

Adheesh Budree

November 2014

Signed:...............

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1. Introduction

1.1. Prologue

Business Intelligence (BI) systems have become a must-have in any progressive business today – in order to monitor the current situation and plan for the future. While many acknowledge that there is value in investing in BI systems, few have managed to gauge whether these capital outlays have been successful in providing value to the business, or not.

Thus far, few studies have explored the non-financial factors influencing the success of BI systems or the links between these factors. Cavalcanti (2005) investigated the relationship between different BI practices, specifically environmental, market and consumer intelligence; with little insight into the success dimensions of BI Systems. Ranjan (2008) added guidelines to this body of knowledge for successful BI implementation – in terms of users, technology and the desired firm goals; but this study still lacks the necessary interconnections between these dimensions (Popovič et al., 2012).

The point of departure for this study will be the conceptual studies that have been conducted by the likes of Lönnqvist and Pirttimäki (2006) and Popovič and Jaklic (2010). In these studies a conceptual framework for the model of economic value for BI systems has been identified. However, no benchmark models detailing the relationship between the successful factors that impact the value of BI systems were found in the literature reviewed.

By using the theoretical framework specified in Montgomery (2012), this study will also make use of value theories, which take into account both the theoretical and the practical issues of BI Systems. By determining the key factors impacting BI systems – through an extensive literature review – a model of the interactions between the factors can be created. The model created will be used as a benchmark to test for the presence of the key elements impacting the value-add of BI systems in businesses by way of an online survey.

This chapter outlines the overall structure of the thesis, beginning with a background of the research, followed by a clear statement of the problem being investigated. An overview of the research objectives is given in section 1.4; while Section 1.5 is a summary of the research approach and the methodology used. This is followed by the definitions of the main terms used in the research. The final section of this chapter gives an outline of the entire structure of this thesis; and how it should achieve the formulated research objectives.

1.2. The Research background

BI Systems refer to the use of Information Systems to collate raw data into information that can be reported on, with the end goal of using this information to enhance the business decision-making process. This goal is enabled by making use of information that is complete, relevant, accurate, timely and accessible. This is a widely accepted and implemented paradigm in business today. However, few studies have been conducted to understand the true value added and returned on the investment of BI systems for a company (Ranjan, 2008;Popovič et al., 2012).

There are currently a number of documented perspectives that could be used to gauge this value. However, from an overall business-value perspective, the most robust method would be to identify and analyse the most commonly identified factors that impact the value assigned to BI systems by a company, and the correlation of each of these factors to the overall value (Lönnqvist and Pirttimäki, 2006; Popovič and Jaklic, 2010; Montgomery, 2012).

Viviers and others (2005) found that there is a sustained level in awareness of the value of Competitive Intelligence systems. The level of awareness identified is also synonymous with BI systems – but with the addition of external competitor data, in addition to internal organisational information, and the knowledge in South African organisations. However, no empirical information is available to point towards the increase in this awareness since the first descriptive research on the value of BI systems in South Africa conducted in 1999.

Viviers and others (2005) further suggest that South Africa is lagging behind in terms of competitive and BI – in that it is not integrated and embedded in South African organisations in alignment with the organisation's infrastructure – as well as not being able to adequately reflect trends and adapt to changes.

In particular, in terms of the extent and depth of education, training and consulting services, South Africa is far behind most developed countries (Viviers et al., 2005). Du Toit (2003) concluded that large amounts of money are already being spent in the generation, processing, retrieval, evaluation, packaging and dissemination of information. Though spend on data management is large it does not mean that the quality of intelligence systems in the South African manufacturing industry is adequate (Du Toit, 2003).

Campbell (2014) supports Du Toit (2003) where it was found that even though on average South African organisations with an implemented BI system had a marginally higher level of perceived organisational performance, the results were not statistically significant enough to ignore the null hypothesis of no effect of BI systems on performance.

According to the 2014 German Chief Information Officer (CIO) Agenda Gartner (2014), there is a growing realisation from the German perspective that companies in Germany need to invest in Information Technology. This investment is done in order to remain competitive, with the highest identified areas of spending being Enterprise-Resource Planning and BI. It also demonstrates a shift in organisational thinking from efficiency to growth and innovation, which supports a move from investing in systems that support the operational aspects of organisations to BI and analytical systems that support organisational growth (Gartner, 2014).

The sample described above will be used to assess the factors identified in the literature review, and to assess the value of deriving a conceptual model that consists in its enablement of companies and government bodies to assess the true value addition of BI systems. In doing so, companies would be able to justify or refute any further investment in BI systems. Furthermore, global organisations, such as the World Bank, could assess the value of data and information to businesses and non-profit organisations, and make recommendations on further funding and the roll-out of technology to developing countries.

The research for this thesis will be conducted as part of a project that is collaboratively being run by the Neu-Ulm University of Applied Sciences in Germany and the University of the Western Cape. The research will be conducted across organisations in both South Africa and Germany simultaneously, with detailed surveys investigating the usage of BI Systems and Corporate Performance Management.

These surveys were distributed to Chief Executive Officers (CEOs), CIOs and BI Managers in selected organisations.

The research that applies specifically to this thesis will focus on BI systems across the South African and German corporate business environments. To this end, it will use portions of the research conducted, as part of the wider project.

1.3. The Problem Statement

Autor (2014) demonstrates that spending on technology has been decreasing since the dot-com bubble burst and continued when the financial crisis started, with the sub-mortgage crisis in 2008/2009. It is therefore important for organisations to ensure that their IT spending is invested appropriately, in order to reap the best value for the monies spent. From literature reviewed, it is clear that there is no one method to assess the value of purchasing a BI solution in organisations (Gibson and Arnott, 2002).

From the literature reviewed, it is also clear that a problem lies in the understanding the true value added from the implementation of BI systems (Ranjan, 2008;Popovič et al., 2012). Without the ability to assess the true value, it is difficult to justify the spending on BI systems. It therefore becomes important for organisations to be able to assess this value in order to allocate technology spending accordingly, and to reap the rewards of this investment.

Based on the description of the problem of assessing the value of BI systems, the main research questions for this study can be formulated as follows: "What are the factors impacting the value of BI Systems and their individual contributions? Furthermore, can their combined effect be modelled to assist in making a BI system decision, in order to enhance decision-making and add value to an organisation?"

The above main research question can be broken down into the following sub-questions:

1. What are the main factors that contribute to the value that BI investments add to organisational growth?
2. How can these factors be represented in a conceptual model in order to demonstrate their value?
3. How applicable is this conceptual model to organisations in South Africa and Germany?

4. Can this model be revised based on data from South Africa and Germany?
5. What final combined Conceptual Model could be derived?

1.4. The research objectives

The main research objective of this study is to establish, document and quantify the variables and their relationships that impact the value BI systems add to businesses, specifically in terms of business growth. This can be broken down into the following three core objectives:

- Establishing a theoretical factor-based model through a thorough literature review.
- To empirically test this model with quantitative data.
- Categorising and deriving the final conceptual model. This will be done by evaluating the responses gleaned from the quantitative study, and the relationships that exist between these factors and the value of BI systems.

The final benchmark model could then be used to establish the value that BI systems add to organisations – in practical terms.

1.5. Scope and limitations

This research project forms part of a larger BI project being conducted collaboratively by the Neu-Ulm University of Applied Sciences and the University of the Western Cape. While the larger project delves into the impact of BI investments on Corporate Performance Management, the scope of this project will be focused on the identification of a conceptual model that would adequately describe and assess the relative contribution of the identified factors that impact the value of BI systems in the corporate environment.

As such, the results of this study are limited as follows:

- Focus on only the major variables/factors identified from literature and vetted by the online survey conducted that influence the value of BI systems. The factors that are identified in this study are the most commonly discussed factors in current literature and are moderated by the survey conducted. This is not an exhaustive list and other factors will also contribute to the value of BI systems.
- The geographical area for this study is limited to South Africa and Germany.
- The business environment for this study is limited to organisations that operate out of, or alternatively have, a large end-market office based in either South Africa or Germany.
- The study will be limited to medium and large businesses that have already implemented a BI system.
- While some definitions of BI include Competitor Intelligence, this study is focused on the internal data sets that are analysed in the business.

As this study will be conducted in conjunction with the Neu-Ulm University of Applied Sciences and the University of the Western Cape, the data that will be analysed will be limited to those which appear in the survey that has been agreed upon by all the parties involved in the project.

Despite the questionnaire gathering much more data than the value associated with the implementation of BI systems in South Africa and Germany, the subject matter of this study will be limited to the two countries.

1.6. The Research Methodology

This study analysed the current information available, in order to draw out key factors and add to them by building a conceptual model that could represent the value of a BI system to an organisation. The study will focus on the variables, and will test their viability by means of a factor analysis, based on the primary data gathered through the use of questionnaires.

The research in this study will be primarily quantitative based on a full literature analysis of the topic, and all the significant fields that impact on that topic.

The literature review that forms part of the study focuses on identifying and quantifying the most important factors identified by current literature that impact the value of BI systems. This includes journals and academic articles, past studies and case studies that have centred on the value of BI systems and the quantification thereof. The quantitative analysis is based on the survey being conducted by Neu-Ulm University and the University of the Western Cape, based on a thorough literature review conducted.

The details of the quantitative survey are as follows:

Development of the questionnaire

Based on a thorough literature study, the online survey was designed over a period of two years, with consultation across academia, BI systems providers, such as SAP and Tableau, as well as large corporate organisations using BI systems. During the initial Project Workshop conducted in July 2010, Value Measurement was presented as the largest issue in BI systems, as identified in an empirical study in Germany (Technical University Chemnitz, 2010). From this initial workshop, the survey design took shape, using the input from ten corporate organisations and two universities.

The online survey is split into two areas, specifically: a corporate performance management (business-centric) section and a BI (IT-centric) section, where the respondent can choose which section they wish to represent. The aim of the research is to analyse whether and how far BI systems could enhance the success of organisations – in terms of planning, monitoring and control of the strategic and operational business activities.

The first part of the survey deals with general organisational descriptive questions, such as the company turnover, company performance, the number of employees, the length of operation, the industry, and the company's operational, reporting and technological design. Once the descriptive aspect has been covered, the questionnaire moved into: either corporate-performance management or BI specific questions.

Key questions were presented with a seven-point Likert Scale, with the possible answers ranging from "Totally disagree" to "Totally agree" and included a statement "not relevant" and "I do not know" option. In this way, the answers received flexibility, in order for the researcher to make use of a variety of statistical analytical approaches, including correlation analysis, factor analysis, discriminant analysis, and structural-equation modelling.

Open questions were finally asked at the end of each survey on the largest value items and foreseeable future issues that the respondent associates with corporate-performance management and BI systems.

The questions were arranged in groups that could be used to assess a specific focus area. For BI systems, the dimensions were identified as follows:

- Technical Integration;
- Functional Scope;
- Technical Information Quality;
- Governance and Operations;
- Consistency of the Data Models;

- Automation of processes;
- Process-Management functionalities;
- Logical-Data Aggregation;
- Traceability to the original source;
- Data consistency;
- Consistency of Tools;
- Data completeness and integrity;
- Data timeliness;
- Technical Documentation / Conventions;
- Clear & Transparent establishment of responsibilities;
- Binding IT architecture;
- Consistency of Tools;
- Analytical Functionality;
- Presentation / Delivery;
- Comments & Extensions;
- Compliance and User rights / Legitimacy.

<u>Population and sampling</u>

The questionnaires were distributed to both South African and German companies, with a larger number of German respondents, because of the large size of the corporate industry in Germany. The calculated sample was made up of respondents from medium and large organisations, split between Chief Executive Officers / Managing Directors for the Corporate-Performance Management aspects, and Chief Information Officers / IT Directors for the BI aspects. The response rate required was approximately 10%, in order to have a solid research sample within an acceptable confidence-level range.

Gathering of the data

The target population comprised specifically senior IT managers, Chief-Information Officers or BI Managers; and they were reached via an online survey. Random samples had been drawn from lists made available of companies listed on the South African stock exchange, and by German business groups. Furthermore, emails were sent to a purposive sample of organisations – chosen, according to their industry standing, as well as their investment in BI systems.

In order to ensure a good response rate, follow-ups were done via reminder emails, as well as by dedicated project resources engaged in telephonically calling respondents, who had started the survey, but had not completed it.

Analysis and interpretation of the data

Analysis was be conducted by using a combination of the literature and the concepts currently available, together with the quantitative results extracted from the questionnaire being run by the BI project. Once this has been done, the model will be tested against the information gleaned from the quantitative data of organisations, in order to assess whether these factors are present. This will be done by using the most appropriate Factor-Analysis-reduction method, depending on the results of the study, and thereafter assessing the results by using a Partial-Least-Squares analysis.

1.7. Definition of terms

Table 1.1 – Definition of terms

Term	Definition
Analytics	The process of evaluating information within a particular domain, and applying BI systems capabilities to a defined content area (Gartner, 2014).
Big Data	Processing of large volumes, at a high velocity, and varied information in a cost-effective and innovative manner to enhance insight and decision-making (Gartner, 2014).
Business Intelligence (BI)	BI is the application of analytical tools on stored transactional data, in order to understand the business better, so that one can plan and make business decisions.
Competitive Intelligence (CI)	Information regarding an organisation's internal workings and external environment, in which it operates, that is gathered and analysed, in order to give the organisation a competitive edge. BI differs from Competitive Intelligence, in that it focuses only on the data gathered and analysed internally, and does not include competitor information.
Corporate-Performance Management (CPM)	CPM is the analysis of a series of activities that indicate the overall performance of the organisation.
Data	Raw facts about people, places, events and things of importance in an organisation. On its own, each fact is relatively meaningless (S. Williams and N. Williams 2007).
Data mart	A basic form of a data warehouse focused on a single subject (or functional area) (Oracle, 2014).

Data warehouse	A storage structural design that accommodates the data extracted from transaction systems, operational data stores and external sources, which it combines into an aggregate, summary form for enterprise-wide data analysis and reporting for predefined business needs (Gartner 2014).
Information	Sets of data organised in a specific context representing the organisation and its external environment (S. Williams and N. Williams 2007).
Information Management	Information Management consists of identifying what information is required, the sources and methods of gathering, the organisation, where it is stored, and the accessibility and security. The goal is to maximise the usefulness, when making decisions (Pirttimäki, 2007).
Information System / Technology	Technology or a system that is used to collect, store and analyse information. In the context of this study, information systems and information technology are synonymous with the BI system.
Intelligence	Information that has been analysed (Fuld, 1995).
Knowledge Management	A process that formalizes the management and uses of an enterprise's intellectual assets, which promotes a collaborative and integrative approach to the use of information assets (Gartner, 2014)

1.8. Research Contribution

This thesis is targeted at both BI academics and practitioners. From an academic perspective, this thesis is aimed at those who are interested in the value of BI systems: both from an Information Systems' perspective and Strategic perspective, specifically the assessment of said value in the use of information and all its attributes. This study focuses on filling the gap that was identified in the literature reviewed that brings together the major factors documented that impact on the value of BI systems and assess the relationships between them using statistical methods.

From a practitioner perspective, this thesis aims at providing a model that can be used as a benchmark to assess whether a specific organisation, or group of organisations – be they economically, geographically or industry-wise – have all the necessary factors in place, in order to derive value from the BI systems. The model derived can then be used in organisations to make BI systems-related decisions.

1.9. Thesis structure and chapters

Chapters Two and Three contextualise the study and its environment by assessing the most relevant literature available on the subject matter. This content is presented in sections detailing the role of BI systems in the business environment, as well as in a South African and German context (in Chapter Two) before delving into the specific factors identified in the literature that impact the value of a BI investment (in Chapter Three).

This leads into Chapter Four, where the research methodology and the conceptual design of the benchmark model derived from the literature, together with the research design for this study, are explained.

This includes an overview of the larger project tracing the link between BI systems and Corporate-Performance Management, being collaboratively conducted by the Neu-Ulm University of Applied Sciences and the University of the Western Cape.

It then discusses the common survey components shared between this study and the project. This chapter will also discuss the sample used, as well as the data-collection process.

Chapter Five presents and analyses the findings of the online survey, and compares these findings with the benchmark model. The analysis will include a Frequency, Skewness and Kurtosis analysis by question, a Factor Analysis – using the appropriate method – and a Partial-Least-Squares Analysis.

Chapter Six will present the conclusions, based on the findings of the study; and additionally, it will recommend areas for further study.

1.10. Conclusion

This chapter has summarised the overall structure of the thesis, including a background to the research, a clear statement of the problem being investigated, an overview of the research objectives, the research approach used, the definition of the main terms used in the research, and finally an outline of the entire structure of this thesis, and how it intends to achieve the research objectives set. The next three chapters outline the literature review that forms the foundation of this study.

2. Contextualising the study

2.1. Introduction

BI has gained significance in businesses across the globe – since the term was defined in the late 1980s by Howard Dresner, a Gartner Research-Group analyst, (D. J. Power, 2003; Buchanan and O'Connell, 2006). It was intended for use as a means to analyse business activities and trends, and to use these analyses to plan and strategize for the future. While authors such as Vitt and others (2002), describe BI as a fairly recent development, a pre-cursor definition of BI that was presented by Luhn (1958) more than 50 years ago in his selective dissemination of information (SDI) technique.

The total investment by organisations in BI is 13.8 billion US dollars (Gartner, 2013). Gartner (2013) further highlights the reason for this as being an unmet demand in organisational areas, such as marketing and human resources, as well as the developing demand for data as a service, together with the offering of diagnostic, predictive and prescriptive capabilities that would add value to any organisation. Sangar and Iahad (2013) show that a large gap exists between academia and BI practitioners regarding the critical success factors that impact the value of BI systems. This gap is represented by criticisms of academia on the lack of theoretical understanding of practical concerns around the critical success factors of BI systems (Yeoh, 2010).

This chapter will investigate the definition of BI in current literature, and specify its context in both South Africa and Germany, before describing the variables required for modelling specific to BI. The next chapter will continue with a review of the literature with regard to the identified variables that impact on the value of BI.

2.2. Defining BI

BI is the application of analytical tools on stored internal and external data, in order to improve the understanding of the business, and thus increase the quality of planning and business decisions (Sangar and Iahad, 2013). Negash (2004) states that by making use of BI systems, organisations can better understand the capabilities available to the business, as well as the trends and future directions of the markets in which the business operates. While these observations are made at an operational level, BI systems are widely used at executive and management levels to support organisational and strategic decision-making.

Historically, BI has been in existence in many different guises for over the last few decades, with the term – at least partly – replacing several functions of Management-Information Systems, Executive-Information Systems and Decision-Support Systems in more recent times (Thomsen, 2003). Ranjan (2009a) states that researchers have been using the term "intelligence" since the 1950s, with the term BI becoming popular in the 1990s, and Business Analytics, which allows data analytics on organizational data, in the 2000s. These techniques, together with their terminology, were introduced to represent the key analytical components in BI (Davenport, 2006).

Negash (2004) demonstrates the process of a BI system as a system that accepts unstructured data from informal systems as well as structured data from formal systems, as specified by analyst requirements, as inputs and combines this data into meaningful information that can be used for organisational decision making.

The change in the usage of the term intelligence, in the context of Information Technology, demonstrates a shift from understanding an organisation's internal processes to a much wider perspective – to include also an understanding of the environment in which it operates – and eventually building the capability to conduct forecasts and predict business changes, based on the combination of internal and external information (Popovič, 2010). This is then built further by Chen and others (2012) who view BI from the perspective of analysing unstructured data, in order to better understand the business and its consumers, thereby enhancing the ability to predict future behaviour.

Isik and others (2010) summarise the most salient definitions of BI in literature, as presented in Table 2.1.

Table 2.0.1 - BI Definitions

BI definition	Author(s)	Definition focus	Decision-making / analytics / predictive
An umbrella term to describe the set of concepts and methods used to improve business decision-making by using fact-based support systems	Dresner (1989)	Technological	Decision-making
A system that takes data and transforms them into various information products	Eckerson (2003)	Technological	Analytics
An architecture and a collection of integrated operational, as well as decision-support applications and databases, that provide the business community with easy access to business data	Moss and Atre (2003)	Technological	Analytics
Organised and systemic processes, which are used to acquire, analyse and disseminate information to support the operational and strategic decision-making	Hannula and Pirttimaki (2003)	Organisational	Decision-making

process			
A set of concepts, methods and processes that aim at, not only improving business decisions, but also at supporting the realisation of an enterprise's strategy	Olszak and Ziemba (2003)	Technological	Decision-making
An umbrella term for decision support	Alter (2004)	Organisational	Decision-making
Results obtained from collecting, analysing, evaluating and utilizing information in the business domain	Chung and others (2004)	Organisational	Analytics
A system that combines data collection, data storage and knowledge management with analytical tools, so that decision-makers can convert complex information into competitive advantage	Negash (2004)	Technological	Decision-making
A system designed to help individual users manage vast quantities of data and help them make decisions about organisational processes	Watson and others (2004)	Organisational	Decision-making
An umbrella term that encompasses data-warehousing (DW), reporting, analytical processing, performance management and predictive analytics	White (2004)	Technological	Predictive Analytics
The use and analysis of information that enables	Burton and Hostmann (2005)	Organisational	Decision-making

organisations to achieve efficiency and profit through better decisions, management, measurement and optimisation			
A managerial philosophy and tool that helps organisations manage and refine information with the objective of making more effective decisions	Lonnqvist and Pirttimak (2006)	Organisational	Decision-making
Extraction of insights from structured data	Seeley and Davenport (2006)	Technological	Analytics
A combination of products, technology and methods to organise key information that management needs to improve profit and performance	S. Williams and N. Williams (2007)	Organisational	Analytics
Both a process and a product, that is used to develop useful information to help organisations survive in the global economy and predict the behaviour of the general business environment	Jourdan and others (2008)	Organisational	Analytics
A collection of decision-support technologies for the enterprise, aimed at enabling knowledge workers, such as executives, managers, and analysts to make better and faster decisions	Chaudhuri and others (2011)	Technological	Decision-Making

The ability to mine unstructured user-generated contents, leading to unprecedented intelligence on consumer opinion, customer needs, and recognising new business opportunities	Chen and others, (2012)	Operational	Predictive Analytics
Big Data emerged in 2011 as the latest chapter of BI (BI) and Business Analytics (BA), representing new and unusual sources of data (e.g., sensors, social media), advanced technologies (e.g., Hadoop architectures, visualization, predictive analytics), and rare combinations of user skills (e.g., data scientists)	Wixom and others, (2014)	Operational	Predictive Analytics

The above listing demonstrates clearly that BI cannot be classified as merely a technological phenomenon, but also an organisational and human one with both operational and strategic perspectives. This implies that BI value investigations must focus on more than just the technology component. There has also been a clear development over the years in the BI sphere that has led from decision-making systems into analytics, and has now become the key for predictive analytics across large sets of data.

English (2005) takes this argument further by demonstrating that the issue with many BI definitions is that they are focused: on either the software or the technology components. The figure below (Fig. 2.1) represents the supportive argument from (Popovič, 2010).

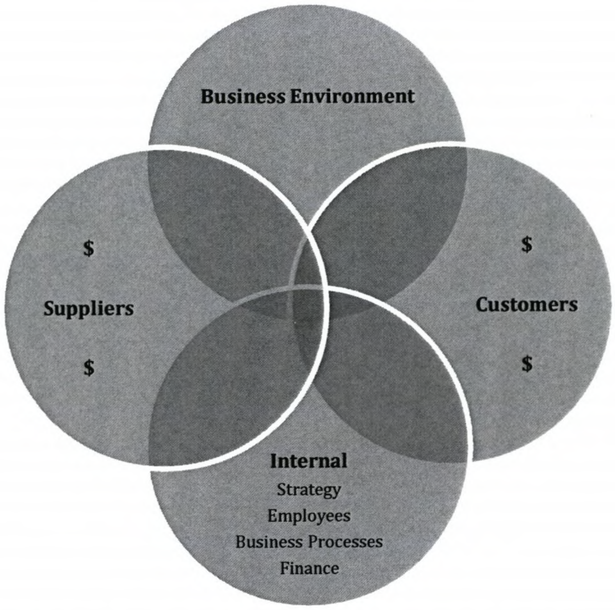


Figure 2.1 - Broad concept of the impact areas of BI adapted from Popovič, 2010

Popovič (2010) continues the all-encompassing definition of BI argument by stating that the essential element of BI is an understanding of the internal processes of the organisation, which have crossed all spectrums of the organisation, from the executive to the operational. The diagram above (Figure 2.1) also demonstrates the impact of ensuring that the internal process are running efficiently, and that they have a knock-on effect on all aspects of the business model.

From a strategic perspective, Willen (2002) highlights a Gartner survey that has ranked the strategic uses of BI in the following order:

1. Corporate performance management;
2. Optimizing customer relations, monitoring business activities, and traditional decision support;
3. Packaged stand-alone BI applications for specific operations or strategies;
4. Management reporting of BI.

As shown by the listing above, by its very nature BI supports a strategic environment of proactive decision-making that delivers value to the organisation. These findings show that the most important strategic use of BI systems is the impact that these systems have on corporate-performance management, which is tied into the remaining three strategic uses. These have been identified as: the optimisation of customer relations; tailored BI systems, targeted at specific operations or strategies; and the reporting of business issues at an executive and management level.

As time has progressed, technology and data-management processes have become more advanced leading to greater advances in BI. These advances have increased exponentially, with the advent of web architecture. In more recent times, the terms: "big data" and "big data analytics", are now being used to describe the growing masses of data and application-analytical techniques that require advanced data storage, management, analysis, and visualization technologies – due to the enormous size of the data (from terabytes to exabytes) and complexity (from sensor to social media data) (Ranjan, 2009a; Wixom et al., 2014). These above issues are supported by the term Big Data – evolving to define datasets that are so large that they are beyond the ability of typical database software tools to be able to capture, store and analyse such data (Chen et al., 2014).

2.2.1. Technologies

The technological backbone of a BI system is two-fold, namely storage and reporting support. Data stores can take the form of any storage platform – from a simple database, to a complete corporate-data warehouse. The key factor for successful BI solutions is clean data. These can be described as data that abide by the CRATA (Complete, Reliable, Accurate, Timeous and Available) requirements.

The ISO 8000 standard (ISO/TS 8000-1:2011) was initiated by the International Organisation for Standardisation (ISO), to create a global data-quality standard against which the data can be measured. Data are often also locked into certain licensed systems or software, which restricts the use thereof. By complying with the ISO 8000 standard that requires the automation, generation, and distribution of requests, data can no longer be limited to specific systems and software applications. ISO 8000 data are thus portable data, independent of any licensed software applications.

Because of this direct system integration, human interventions that could cause data-capturing errors can be eliminated.

As mentioned, the second part of the technological backbone is the reporting support solution that sits on top of the storage solution – allowing the slicing and dicing of the data – in order to create meaningful information. These two legs work hand-in-hand, in order to deliver clean information that can be analysed to enable effective decision-making and planning. Ranjan (2009) highlights the point that the main technological components of BI are the following:

Online analytical processing (OLAP)

OLAP refers to the manner in which the slicing and dicing of the data, by means of supporting tools, occurs – while allowing for the navigation of different dimensions, such as time and hierarchies. It provides a summarised view of the data across all dimensions that can be used for a number of activities, such as reporting, modelling, analysis, planning and strategy building (Ranjan, 2009a; Khan and Quadri 2012).

OLAP tools and techniques can be used in conjunction with data warehouses, or data marts, which are queried by users, in order to do trend-and-factor analyses across large amounts of data, and by making use of reporting software, aggregate views of data can be developed and reported, across different levels of the organisation (Mansmann, Rehman, Weiler, and Scholl, 2014).

Advanced analytics tools

This refers to software with the ability to conduct data mining, forecasting and/or predictive analytics, by taking advantage of statistical analysis tools, in order to predict or provide measures of certainty on the facts provided (Ranjan, 2009a). This has developed further in recent years with tools, such as Tableau, which without the need for complex database structures allows for power to be pushed back to the user, and the option for collaborative analytics to be conducted (Morton, Balazinska, Grossman, Kosara, and Mackinlay, 2014).

Portals, scorecards, dashboards

This reporting level is at a management or executive level, where a number of sources and dimensions are combined, in order to present an aggregated view of the organisation. This is done, in order to assess the current performance of the business against the measures set, as well as to plan and strategize forward (Ranjan, 2009a). LaValle, Lesser, Shockley, Hopkins, and Kruschwitz (2013) state that the staple requirement for management in any progressive organisation today is data visualisation; analytics attached to business processes, and advanced statistical capabilities.

Visualisation of the data at management level has become paramount, including tools, such as animated maps and charts to assess any critical changes in the distribution flow, or project changes in consumer behaviour, and resource availability (LaValle et al., 2013).

Data warehousing and data marts

Choudhury and Dayal (1997) defined a data warehouse as a collection of data that is subject-oriented, integrated, time-varying, and non-volatile. This is key to the decision-making of any organisation. The data warehouse is normally a stand-alone system that is separate from transactional systems. The data warehouse focuses on the online analytical processing (OLAP); while transactional systems are focused on online-transaction processing (OLTP).

Data warehouses are concentrated on decision-making support using historical, summarised and consolidated data derived from detailed transactional records across multiple systems. Due to the storage of large sums of data from a number of sources over extended periods of time, data warehouses tend to be much larger than operational databases (Ponniah, 2013).

The querying of these large amounts of data requires large volumes of resources to handle complex and intensive routines, much of which tend to be *ad hoc*. In order to facilitate this, data warehouses are organized into a number of dimensions and facts – to facilitate multi-dimensional querying (Ranjan, 2009; Ponniah, 2013).

While most businesses would ideally like to have a central integrated data warehouse, with data that spans the enterprise, this is a time-consuming and complex activity. It requires a thorough understanding of the data present across the entire business, and the creation of models that show the interlinking of different datasets. It also requires the buy-in of all key stakeholders, failing which, the effort would not be supported (Ranjan 2009a; Ponniah, 2013).

This structure may be too complex for some organisations to create and manage centrally; and therefore, many organisations make use of subject-oriented data marts, owned and operated by data owners. An example of this is a marketing data mart that would usually include data – ranging from sales to products and SKUs (Stock-Keeping Units), to consumer information. While data marts are easier and faster to roll out; as it is up to the data owners to manage the roll-out of individual data marts, complexity creeps in when data marts require integration across the business.

Furthermore, the duplication of data across several individual data marts often leads to inconsistencies (Ranjan 2009a; Ponniah, 2013).

2.2.2. Data quality

A key issue related to BI is that it hinges on the use of proper information. This means that if bad data are used initially, bad information is the result. As Negash (2004) emphasises, the larger the volumes of data being used in today's analytics, the higher the probability of errors and anomalies in the data, such as inconsistent field lengths, inconsistent descriptions, inconsistent value assignments, missing entries, violation of integrity constraints, as well as inconsistencies introduced by the use of optional fields in data-entry forms.

Data quality is seen as the ability to present data as accurately as possible, according to predefined requirements, to ensure that that data add value (Freitas, Reis, Michel, Gronovicz and Rodrigues, 2013). This may be a driver for data cleansing to become a key focus area of late.

Negash (2004) identifies three classes of data cleansing tools, namely: data-migration tools, which allow for simple transformation rules to be specified; data-scrubbing tools, which use domain-specific knowledge, such as postal codes to scrub data by means of parsing and fuzzy-matching techniques, and data-auditing tools, which investigate the rules and relationships by scanning the data, as well as any possible violations of the stated rules. It is also a key issue, on which transactional systems are monitored on a continuous basis, in order to identify data quality-related anomalies (Freitas et al., 2013).

In addition to the need for clean data, the timeliness of the data is also a key element of data quality. Negash (2004) says that there are two key sets of issues to consider, namely: when to refresh; and how to refresh. The first issue looks at the regularity of updates and whether the data need to be updated in real-time, hourly, daily, and weekly and so on. The second issue looks at whether the entire dataset or database needs to be updated, which is sometimes required with legacy systems; but this can prove to be quite expensive; or propagating updates from a primary database – to a replica, or a number of replicas.

In today's age of shrinking timeframes, it may be necessary to supply real-time information, so that the information is still relevant for decision-making when needed. This promotes a proactive use of BI. Langseth and Vivatrat (2003) highlight the main components of proactive BI, as being real-time data warehousing, data mining, automated anomaly and exception detection, proactive alerting with automatic recipient determination, seamless follow-through workflow, automatic learning and refinement, geographic-information systems and data visualisation.

Further to this, Wixom and others (2014) highlight the need for data structures to be able to handle the analysis of large amounts of social data, in order to be able to conduct predictive analyses.

The above discussion demonstrates a traditional technological view of BI. However, with the advent of online and mobile computing, the realm of BI technologies has increased exponentially.

2.2.3. BI online

Chen and Storey (2012) state that with the rising popularity of the Internet and the World Wide Web in the early 2000s, the very nature of data collection and analytics has evolved – with larger amounts of data than ever before being created and made available easily *via* search engines characterised by Google and Yahoo, and e-commerce businesses, such as Amazon and eBay, now allowing the direct interaction of organisations with their consumers and customers. This implies also the ability to collect and analyse masses of consumer information.

By making use of IP-specific data and user-set preferences, together with interaction logs collected via cookies and server logs, the ability to delve into the true consumer needs, and to identify new business opportunities is easier than ever before.

With web intelligence and analytics, and the user content collected through Web 2.0-based social and crowd-sourcing systems (Doan et al., 2011; O'Reilly, 2005), it is now possible to conduct research that revolves around text-and-web analytics for unstructured web content.

This has also led to the use of social media analytics that allow organisations to move away from a traditional business-to-customer marketing model – that was purely mono-directional – to a "conversation" that now occurs between consumers and business on social media (Lusch et al., 2010).

As Chen and Storey (2012) point out, moving organisations forward would bring with it the need to integrate mature and scalable techniques, such as information extraction, topic identification, opinion mining, question-answering, web mining, social-network analysis, and spatial-temporal analysis into existing traditional data and information-management systems.

An emerging area that is currently estimated to only have been marginally tapped into, is that of mobile-data usage. An article in The Economist (Oct 2011) stated that the number of mobile phones and tablets (about 480 million units) passed the number of laptops and PCs (about 380 million units) for the first time in 2011. According to Gartner (2013), 2,001 million mobile phones and tablets were purchased in 2013 versus 299 million laptops and PCs. This is further estimated to drop to 278 million in 2014; while mobile phones and tablets will probably increase to 2,197 million units in the same year.

The use of mobile devices, such as smart phones and tablets, together with their downloadable applications, is transforming most areas in the lives of today's consumers – from education to entertainment to healthcare (Chen and Storey, 2012). This leads not only to a whole new source of information that is real-time and consumer-relevant; but it could also lead to the most leading-edge business opportunities and consumer offerings, based on analytics that can be done on the fly, and acted upon immediately, to deliver instant results.

However, such mobile devices are not yet available. And this has allowed for the analysis of rich geo-location data and behaviour data that allow for never-before available insights into consumers, leading to disintermediation and the replacing of point-of-sales and many other older technologies.

2.2.4. BI in the cloud

Cloud computing is touted as being the latest innovation that is revolutionising the way we store and manage data. The basic idea is to 'outsource' the storage of data to companies running large infrastructures. In this way, individuals and businesses are not required to invest in hardware, software and the maintenance required for the storage of data, but can rather focus on the core business activities (Chang, 2014; Fernández, del Río, Herrera and Benítez, 2013).

Mircea (2008) and Chang (2014) see Cloud Computing as a viable option for use in Information management with the main factors to consider on implementation being: abstract computing, security and an IT service- oriented approach; virtual, dynamic, scalable and massive infrastructure; shared, configurable, flexible, dynamic resources; accessibility via internet from any device; ensuring that the platform with minimal management or a self-managed-utilization model is based on self-service, and that charging is based on consumption (measured service).

The viability of Cloud Computing is backed up by the findings from Abadi (2009), who demonstrates that due to hesitation around the trusting of hosts and the replication required on an ongoing basis, analytical data are more suited to cloud storage than transactional data – because of the data sensitivity and sheer volume of data replication required. This requires efficiency, fault tolerance, a heterogeneous environment, the ability to operate on encrypted data, and the ability to interface with BI applications, as the base requirements for a successful implementation (Abadi, 2009).

2.2.5. Big Data

The last decade has seen a massive increase in the amount of data available and therefore the hardware required to manage and analyse this data. These large amounts of data are a phenomenon known as Big Data. There is strong economic evidence that this data can add benefit to private organisations as well as to national economies and citizens. This benefit can be realised in the form of better productivity as well as enhance competitiveness in both the public and private sectors. (Manyika, Chui, Brown, Bughin, Dobbs, Roxburgh and Byers, 2011)

2.3. BI systems

2.3.1. Defining BI systems

BI systems allow for the analysis of information with the goal of supporting and improving management decisions across business activities (Elbashir, Colier & Davern, 2008). The support and improvement is enabled by making use of data infrastructure (for example ERP systems).

Current BI systems available from vendors such as COGNOS, Business Objects and SAS. These systems normally require infrastructure with the ability to conduct querying, analyses, and reporting. This infrastructure may include online analytical processing "OLAP", data mining tools, statistical analysis, forecasting, and dashboards, as well as data stores such as data warehouses and/or data marts. BI systems are normally used to enhance established ERP systems for example SAP. (Elbashir, Colier and Davern, 2008)

Integration of BI systems into other systems has become a norm Aruldoss, Travis and Venkatesan (2014). BI systems have been integrated with Service Oriented Architecture (SOA), Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), and Mobile systems.

Tanko and Musiliudeen (2012) have conducted a case study into successful BI system integration with SOA in a Telecommunications environment by integrating data from heterogeneous data sources of the organization. By doing so they were able to identify a suitable customer tariff plan and to assess the ability to ensure customer satisfaction.

Studies have demonstrated that when BI is integrated with ERP turn-around time for decision-making is minimised while utilisation of resources is maximised. ERP systems were found to have deficiencies in decision support and analysis which integration with a BI system were able to overcome (Long-Wen and Zhang, 2008).

With BI systems combined with CRM systems, an increase in customer satisfaction and customer relations has been seen (Dien and Douglas, 2010). A combined CRM and BI system has also had a marked impact on online businesses being able to better meet their customer demands (Dien and Douglas, 2010).

Mobile BI systems allow for executives to access real-time business critical data from any location (Sajjad, 2009). This supports an organisations capability to react timeously to information available, enhancing decision-making as well as a flexible working environment.

2.3.2. BI Systems Requirements

The requirements in today's business environment include intelligent exploration, aggregation and analysis of data. A BI system is required to combine data originating from disparate sources across the business. Data needs to be combined across different environments as well, for example, portal systems and statistical analysis. BI Systems are also required to provide up-to-date, real-time and reliable information on organisational activities. (Olszak and Ziemba, 2007; Obiedat, North and Rattanak, 2014).

In order for BI system implementations to be successful they need to be executed rapidly while remaining specific to the organisations requirements, and flexible enough to adapt to changes in the business and its environment, independent of hardware and/or software platforms, scaleable and based on modern technology (Olszak and Ziemba, 2007).

Inevitably, the main deciding factor for the success of a BI system is user-friendliness as users need to integrate the system into their daily work routines and use it effectively and extensively for it to truly add value to the business. The better embedded the system is in the business the more value it is likely to add (Deng and Chi, 2013).

2.3.3. Available BI Systems

BI systems are not only available in their own niche market (Ilczew, 2006), but increasingly software such as MRP II and ERP systems have begun to add BI functionality to their existing offerings (e.g. Microsoft, Oracle or SAP) in order to make their software offering more attractive as a 'one-stop shop' for their clients. OLAP techniques and data mining are also available in database systems (Oracle, Microsoft or IBM) (Olszak and Ziemba, 2007).

A requirement from BI systems is the linkage with planning and budgeting, as well as specialised BI systems for specific environments. Types of BI systems range from specialised BI systems available for specific business environments to freely available open source BI systems and solutions.

Ghazanfari, Jafari and Rouhani (2011) identified six factors that must be taken into account when assessing BI systems that support an organisations ERP system. These factors are analytical and intelligent decision support, providing related experiment and integration with environmental information, an optimisation and recommendation model, reasoning capabilities, enhanced decision-making tools and stakeholder satisfaction.

BI systems also play a role in search-based applications across a number of fields including such as Business, Security, Finance, Marketing, Law, Education, Visualization, Science, Engineering, Medicine, Bioinformatics, Health Informatics, Humanities, Retailing, and Telecommunications amongst others (Obiedat, North and Rattanak, 2014).

2.3.4. Future of BI Systems

The key areas that BI systems are developing are data exploration and visualisation to meet rapidly increasing amounts of data requiring analysis and presentation, cloud computing to combine services and data availability in the cloud and self-service BI with the advent of tools such as Tableau and Qlikview that allow the user to develop reports on the fly without requiring specialist expertise (Obiedat, North and Rattanak, 2014).

2.4. Contextualising BI in South Africa

Since the political change in South Africa in April 1994, competitiveness has become key in South African companies, with a shift towards BI being a strategic business tool (Viviers et al., 2005). This has come to the fore by means of media attention, as well as through conferences, the increased focus on university courses, and the increasing numbers of consulting services focusing on BI. Further promoters of BI include the establishment of associations, such as the Society for Competitive Intelligence Professionals of South Africa (SCIPSA) and the South African Association of Competitive Intelligence Professionals (SAACIP) (Viviers, 2001; Naude', 2001).

Early studies in BI systems in South Africa found that there existed a lack of understanding around BI systems and its benefits. Due to the lack of understanding, BI systems are not being utilised to their full potential (Dawson and Van Belle, 2013)

In South Africa, the focus on BI first surfaced in the business sector, with academia following – since 1999 (Viviers, 2005). According to Viviers (2005), this occurred when the need and implementation of BI came to the fore; resulting in the establishment of university courses, predominantly in the realm of information management.

Simultaneously, consultants developed specialised BI training courses, which helped to establish BI as a true management tool (Viviers et al., 2005).

Research has shown a sustained level of awareness of BI in South African organisations, with major limitations still existing in the training area. In order for this awareness to be made beneficial, BI needs to be integrated into the organisation's operations, by embedding it into the culture and infrastructure, while remaining adaptable to change, and able to reflect current industrial trends (Viviers et al., 2005). This is also visible in the study conducted by Dawson and Van Belle (2013), who found little difference in the critical success factors identified in South African organisations as compared with similar studies conducted across European organisations.

Kahaner (1996, p. 25) believed that BI is the "latest weapon in the world war of economics" for emerging markets, in that it could prove to be the ultimate weapon against competition from developed countries, as they are able to convert data into competitive intelligence that could support their organisations immensely. Ponelis (2011) found that the majority of South African SMMEs did not have the critical success factors in place needed to make BI a success.

South Africa still has a long way to go before it can be identified as a true knowledge economy, particularly with the diversity of its 51.8 million population StatsSA (2011) adding cultural differences to the difficulty of transferring knowledge within organisations. As stated by Du Toit (2003: pg. 118), "...large amounts of money are already being spent in the generation, processing, retrieval, evaluation, packaging and dissemination of information. But that does not mean that the quality of intelligence systems in the South African manufacturing industry is adequate."

This statement applies to all industries across South Africa; since to compete on a global scale, South Africa is required to build the intelligence and the insights of its economy, in order to be able to compete with its global competitors.

Insight in the use of BI systems is required by South African enterprises, in order to thoroughly understand their internal operations; and as such, the factors impacting their operations – thus giving them the ability to adapt and change, in accordance with the demand and a changing environment. It also allows South African companies to plan ahead and put strategies in place that would give them the ability to remain competitive.

Du Toit (2003) points out that proper BI could give South Africa strategic advantages; since commercial success will depend more and more on effectively understanding their businesses and implementing continuous business improvement, based on the data collected and analysed. Since this publication, there has been a number of successful roll-outs of BI in South Africa, such as that of the South African Revenue Service (SARS) and the City of Cape Town Dawson and Van Belle (2013), as well as that of the Western Cape Education Department (WECD) (Lutu and Meyer, 2008).

Dawson and Van Belle (20 conducted study into the critical success factors for BI implementations in the South African financial-services environment, which identified the need for Data Quality as the most important criterion within this sample of financial companies, with the next highest being a combination of business and strategy impact, with technological capability only following in the sixth place.

2.5. Contextualising BI in Germany

Little academic literature, either in English or in German, was found that refers directly to BI usage and trends in Germany. In Gartner's (2014) CIO Agenda Graumann and Kohne (2003), it is mentioned that there is a growing awareness that German Companies need to invest further in Information Technology, in order to remain competitive, with the second-highest highlighted investment required being BI.

In the context of the European financial crisis of 2013, a key challenge faced by Germany with its population of 80.5 million (of which 52% are currently employed) (Statistisches Bundesamt, 2014) is the restoration of its competitiveness, in order to bring back its economy onto a path of strong and sustainable balanced growth, which can only be done via strategic reform aimed at increases in productivity, dynamism and employment.

It was further highlighted that BI plays the role of providing appropriate information to decision-makers, in order to enhance organisational competitiveness within German businesses, thereby enhancing the overall competitiveness of the German economy (Statistisches Bundesamt, 2014).

According to the Europäische biMA®-Studie conducted by Steria Mummert (2013), the availability of analytical information is seen as a critical success factor in German organisations, majority of which have established BI maturity models, while BI user numbers are growing rapidly with the increase in popularity of BI who demand availability, flexibility and stability of data. Data quality is seen as the biggest challenge, with a survey conducted by IBM together with TDWI in 2013 into BI usage in German organisations showing that 17% of respondents have issues with data while 40% expect further issues as data usage rates grow.

2.6. Value modelling in the context of BI

Modelling allows for the development of a logical, abstract template that could help in the understanding of interactions between variables in a market setting, where one can logically isolate factors and investigate cause-and-effect relationships between these elements. Through modelling, it is possible to simulate, and therefore experiment, with different scenarios, in order to weigh up the logical integrity of an argument (Evans and Wurster, 1997).

Evans and Wurster (1997) highlighted the four main types of models used for analysis, namely: visual models, mathematical models, empirical models, and simulation models. This study seeks to identify the variables required to build a visual conceptual model, in order to assess the value of BI, and to test whether these variables are present in organisations across both Germany and South Africa.

Williams and Williams (2003) stated that the value of an investment is the net present value of the after-tax cash flows associated with the investment. Therefore, the improvement of management processes, such as planning, controlling and monitoring allows the management to increase revenues and/or to reduce costs. The figure below (Figure 2.3) is a graphical representation of the model developed by (Williams and Williams, 2003).

Figure 2.0.1 - BI Value (Williams and Williams, 2003)

Specific to BI, Williams and Williams (2003) demonstrate that strategic alignment, process engineering, change management, BI, technical development, and BI project management are preconditions – before the value of BI can be assessed.

This entails an analysis of the BI Opportunity Analysis in terms of the business environment, industry, and internal business, as compared with the BI used to facilitate a strategy, in order to improve revenue and reduce costs; assessing BI readiness to deliver information to BI applications and frameworks; the role of BI in process engineering, to increase revenue and decrease costs; reviewing the return on investment analysis, cost-benefit analysis and/or payback period analysis; and an assessment of the changes required for individuals and processes, and for any skills transfer and/or training required in the implementation of a BI system.

2.7. Conclusion

This chapter has summarised the main literary definitions of BI in current academic writing, and has broken it down into its key components, namely: data, technology and cultural aspects. BI was then contextualised in both a South African and a German environment, as these are the two geographical focus areas of this study.

Finally, the concept of modelling was assessed, specifically in a BI context. The next chapter will investigate the literature findings on the value of BI; and it will highlight the key factors derived from the literature review impacting this value.

3. The Value of BI

3.1. Introduction

Wagner and Zubey (2007) speak of the challenge faced by the pharmaceutical industry on the decision whether to invest in BI. In particular, the question asked is: What organizational value is created with the capital investment required to implement a new BI solution? This dilemma is not unique to the pharmaceutical industry; but it is a challenge faced by organizations on a daily basis. This chapter explores the value of BI systems; and it identifies the key factors in the literature associated with the value of BI systems.

3.2. Evaluating the value of BI

Over the last three decades, IT investments have been made to increase the operational capabilities in businesses – in order to cope with the need for large amounts of data to be processed as quickly as possible (Gibson and Arnott, 2002b). Işık and others (2013) support this in more recent literature with the perspective that the success of an IT investment, for example in BI systems, is directly related to the positive value the organisation derives from it. In order to assess viable IT investments, the literature had to be carefully reviewed in order to understand the return on investment and to clearly demonstrate its ability to improve the efficiency or growth of the business. Likewise, any technological investment that did not speedily make a significant impact on the businesses bottom-line was not a viable option (Whiting, 2003).

Kohli (2003) examined a number of factors, which should be taken into account when deriving the benefit that information systems provide to a company, namely:

- Resolving any doubt about whether information systems add value. Numerous studies have demonstrated a clear relationship between information systems and organisational value, be this financial (e.g., Return on Investment), intermediate (e.g., process-related), or affective –

or from an emotive or a perceptive perspective (Devaraj and Kohli, 2003; Santhanam and Hartono, 2003).

- The value created by information systems is conditional; since this is not merely a question of hardware and software; but of whether it works hand-in-hand with the other organisational systems, such as people (both technical and non-technical), management, business processes, knowledge and relationship assets, organisational culture, overall structures and company policies (Melville et al., 2004; Hulland and Wade, 2004; Kohli, 2003). This supports the earlier definitions of BI, which go further than merely a technological and/or quantitative perspective.
- The value of information systems manifests in a number of ways, due to its newfound pervasiveness in the form of increased productivity, capital value, business-process improvements, organisational profitability (return on investments), improvements in supply chains, or innovation at the inter-organizational level or consumer surplus (Barua and Mukhopadhyay, 2000; Rai, 2006; Kohli, 2003). This value is also present across many levels, such as those of the individual, the group, the firm, industry, or process with models such as the Technology Acceptance Model (TAM). These models are used to predict the value of a system based on its usage both at an individual and group level. This value can be aggregated up to the organisational level, in order to mediate between the investment and the derived value (Devaraj and Kohli, 2003).
- There is a difference between the value brought about by information systems investments, as opposed to the competitive advantage brought about by information systems investments, with the first creating value and the second creating differential value (Hitt and Brynjolfsson, 1996). This perspective has evolved, with authors such as Carr (2003), demonstrating that even though value can be created at the overall industrial level that transcends competition, differential firm value from information systems investments is elusive; since it can be copied and competed away. Therefore, organisations have of late focused more on the value derived from such operational improvements brought on by the

implementation of Information Systems – rather than on any assumed value derived from added competitive advantage.

- The value derived from information systems investments is not always immediate; and a latency (lag) period can be experienced in the return on investment. This is because of the time required for adoption, implementation, and acceptance. This could amount to a number of months or years (Santhanam and & Hartono, 2003). Therefore, the value assessed from BI systems may not be evident immediately; and it may require a time-lag before any significant improvement can be discerned.
- A number of factors exist that are deemed important and necessary conditions in the value creation derived from information systems – investments, including, among others, IS-Strategy alignment, organisational and process change, process performance, information sharing, and IT usage. These are crucial to the translation process and the conversion effectiveness of information systems' assets (Devaraj and Kohli, 2002). This again ties back to the value derived from the non-financial factors associated with BI systems.
- Proving and attributing value, with the task of obtaining granular data on IT investments, assessing changes in IT functionality and isolating effects on a value-based variable, are onerous (Barua and Mukhopadhyay, 2000). The subjectivity of primary data, the inaccessibility of reliable secondary data, the unavailability of appropriate proxies, and the use of cross-sectional designs, inhibit the study of IT value (Kohli, 2003).

BI is a field that has given organisations the ability to assess and improve themselves in the areas of data mining and information generation. This ability has already been recognised by Zuboff (1988), who stated that the systems making it possible to automate, also give a total view of an organization's operations, thereby co-ordinating many levels of data to allow for accessibility for analytical purposes.

A number of modern academics concur with this analysis. According to Davenport (2006), the ability to analyse data has become a critical capability for modern organizations; while Marchand and others (2000) relate the success of a firm to its ability to effectively manage and use information. Both authors refer to this as information orientation, which is defined as the ability to effectively manage information through collecting, organizing, and processing the data (Kohli, 2003). Having effective information management puts companies in a better position to understand their data, and to convert this information into usable information. This procedure is self-evident; since data mining is fast becoming an asset for organisations, in order to create better internal capabilities and new business opportunities.

3.3. Previous Evaluation Attempts

Most returns-on-investment calculations for BI systems use only easily estimated quantitative factors, mainly because an organisation is unable to capture many of the qualitative and intangible benefits that are expected (Farbey *et al.*., 1992; Murphy and Simon, 2002). Despite this difficulty, managers have to justify projects quantitatively, as "cost-benefit analysis has assumed a pivotal position in the information systems' revolution" (Sassone, 1988). Sircar and others (2000) have demonstrated that – while information-systems' investments have a strong positive relationship with sales, assets and equity – they do not show the same positive correlation with net income, as there is a lack of tangible factors with which BI implementations can be associated.

Some studies have been conducted and frameworks built, in order to justify the value of BI systems from different perspectives (Watson and Haley, 1998; Watson, et al.., 2002). Sentry Market research and an IDC study Power (1997) previously presented possible sources for the benefits of such systems. Wu (2000) looked at the importance of evaluating both tangible and intangible benefits before a BI project is undertaken; while Morris (2003) presented a comparative study on the costs of building versus buying a BI system. Elbashir, Collier and others (2008) support these models by demonstrating that BI impacts business processes, which in turn, influence organisational performance. Popovič (2010) builds on these past theories by assessing BI systems' maturity, as a gauge to assess the use of quality information to improve business performance – this is a theory, which was termed BIS exploitation.

Webster (1994) defined a tangible benefit as an object that can be appraised at an actual or an approximate value. However, a definition such as this does not specify whether the value attached is necessarily a monetary value or some other intangible measure, such as customer satisfaction (Murphy and Simon 2002).

The historical distinction between tangibles and intangibles lies originally with that of goods and services, with philosophers, such as Smith (1776), stating that while goods were material and could be stored, services were merely immaterial and transitory (Murphy and Simon 2002). Remenyi and others (2000) attempted to differentiate by stating that a tangible benefit impacts an organisation's bottom line; while an intangible benefit is a benefit that directly affects the firm's profitability.

On the other hand, Hares and Royle (1994) defined an intangible very simplistically as something that is difficult to measure; and they maintained that it is difficult to differentiate clearly between the two, with the example that the Generally Accepted Accounting Principles (GAAP) state that money spent training staff is an expense with no future value; but from a business perspective, the value of a skilled employee with the necessary training far exceeds the value of the training expense (Murphy and Simon 2002).

Determining the intangible benefits derived from information systems' implementations has been the subject of many investigations; but thus far, few firm conclusions have been drawn from academics or practitioners (Davern and Kauffman, 2000).

Hares and Royle (1994) break down intangible benefits of information system implementations into four groups, namely: Internal Improvement, Customer Service impacting ongoing benefits, Foresight and Adaptability impacting future benefits.

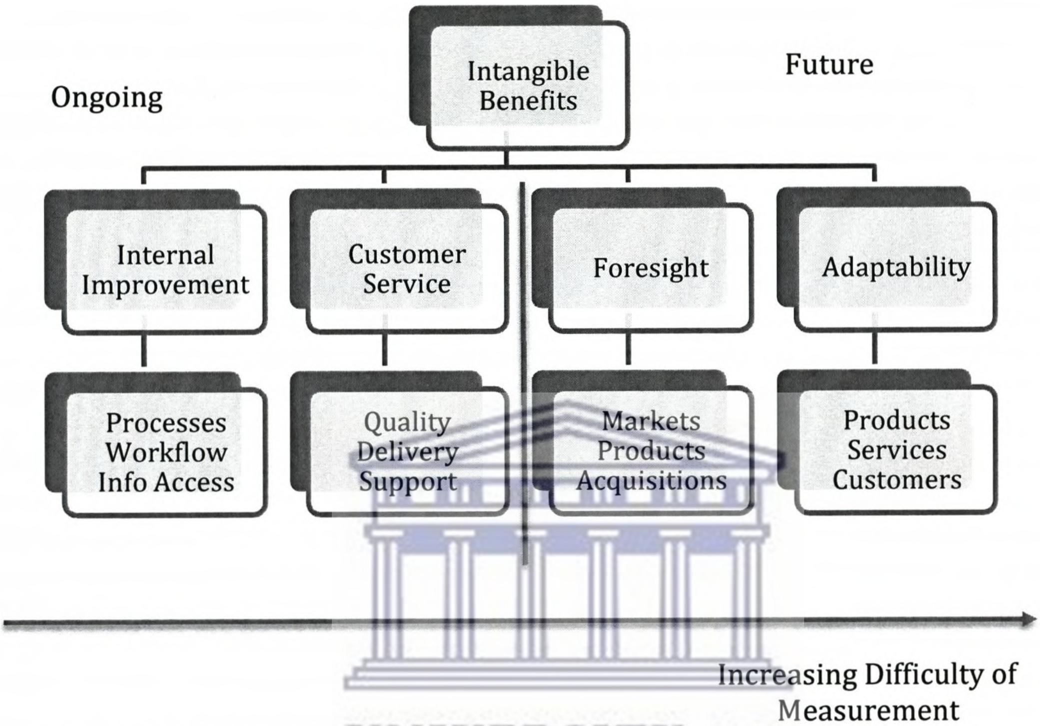


Figure 3.1 - Intangibles (Hares and Royle, 1994)

The first ongoing intangible benefit is that of the internal improvement of the organisation's performance and operational processes. This could include the improvement of production processes, operations management and process chains, which result in increased output and/or lower production costs.

The next benefit is customer service, which is more difficult to put a value to; as this impacts on customer satisfaction and improved customer retention. Although customer satisfaction is often measured by means of quantitative and qualitative satisfaction surveys, it is not easy to express the level of satisfaction in value terms.

The first future intangible benefit is that of foresight; since organisations can identify market trends and movements and predict trends before they occur, which gives the company an opportunity to innovate with products and services to meet changing demands, based on these new trends. However, expressing the value of innovation in concrete terms is not an easy task.

Finally, the last future intangible benefit is that of adaptability; since the organisation can identify changes in the market and adapt its processes and/or products to meet those changes. Agility is a key capability in today's global economy, where rapid responses ensure speed in reaching the market and competitive advantages; but this is not easily translated into a measure of value.

In a similar discussion on the tangible, intangible and benefits associated with the value of BI, Popovič (2010) states that though there are perceived benefits from BI systems, these benefits are only indirect, since the true value lies in improved business processes, which lead to improved business performance and create substantial and sustainable competitive advantages. Porter and Millar (1985) demonstrated that information systems, such as BI systems can affect the performance of individual process activities, as well as greatly enhancing an organisation's ability to exploit linkages between these activities, both inside and outside the company *via* the management of new information flows.

Chamoni and Gluchowsk (2004) and Williams (2004a) show that BI investments can capture true benefits by achieving mature BI systems that support the decision-making processes at an analytical level. IT Strategies, Inc. (2008) research shows that BI systems have one of the greatest potentials for achieving information asymmetry Marchand (2002), which immediately gives the organisation a competitive edge.

In order to ensure a significant return on a BI system, it is necessary to identify and manage those technological changes (such as extraction, transformation and loading [ETL], data storage and information delivery) and business factors (such as competitive advantage, strategic initiatives and change management) that influence the overall pay off (S. Williams and N. Williams ,2007).

While a number of academics agree that BI systems are a necessity in the operation of most modern enterprises (Davenport and Short, 2003; Dewett & Jones, 2001; Li & Ye, 1999; S. Williams & N. Williams, 2007), there is also agreement from many scientific and professional sources that, although these organisations are data-intensive, they are nevertheless, poor on information-management (Forslund, 2007; Gibson, et al.., 2004; Williams, 2004b; S. Williams and N. Williams 2007). This state of affairs clearly implies a lack of ability to convert gathered data into actionable information using the appropriate analytical tools required to improve profits and performance (Popovič, 2010).

Lönnqvist and Pirttimäki (2006) and Turk and others (2006) as well as S. Williams and N. Williams (2007) also highlight that BI systems are simple to quantify in terms of cost; but it is much more difficult to define the benefits that accrue from their use. However, to derive value from a BI system requires resources, which may blur the true benefits of implementation (Lönnqvist and Pirttimäki, 2006). Therefore, Popovič (2010)suggests that two main questions are required, specifically: Why, and how, to measure BI value.

Sawka (2000) suggests that the main reason for measuring BI outlays is to prove the worth of the investment. S. Williams and N. Williams (2007) suggest that the responsibility for value is captured by the business side, in order for the investment to deliver its greatest value. Another key reason for measuring BI activities is to manage the overall BI process, so that the BI systems can meet the users' expectations and foster efficiency (Herring, 1996).

3.4. Solving the problem of assessing the benefits

3.4.1. Knowledge-based Assessment

Pranjic and others (2011a) assert that in order to get a total view of an organisation, it is necessary to gather all the pertinent facts across two distinct dimensions, namely internal knowledge and environmental knowledge. With the first dimension, internal knowledge – whereby using the techniques and tools associated with BI – the organisation gathers large amounts of data, which it converts to usable information, in order to ascertain the trends and opportunities. The information can contribute to the improvement of the business; and it can also track the occurrence of specific events and the effect of those events on the business.

It also enables pre-emptive identification of issues that can be acted upon, and can thus facilitate better business decisions. This is an important point, as it highlights not only the importance of data for an organisation, but also the fact that these data and information are inadequate if the capability and maturity to make use of them is not present within the organisation.

Pranjic and others (2011b) contribute to this argument by showing that the second dimension is gathering data that would provide information that would enable the organisation to better understand the environment in which it operates. This would include the gathering of data on competition, products, substitutes, political stability in operating countries, and unstable movements in the markets – as well as any economic crises, amongst others. Furthermore, in order for correct decision-making to occur, there must be high quality data, access to good systems and training, sound decision-making judgement, trust in management decisions, which again highlights not only the technological aspect of data management, but the organisational one, as well.

The decision-making requirements of an organisation require a solid system to support it, the area in which BI systems are envisaged to add value.

Adidam and others (2012) take this idea further by highlighting that the main factors to consider when assessing the value of a BI investment are the macro- and micro-environmental drivers of intelligence activities; the organisation of intelligence activities within a firm; the usage and dissemination of intelligence activities; the perceived benefits of intelligence in assessing markets and competitors' moves; and the relationship between intelligence activities and the firm's market performance.

3.4.2. Business-Process-based Assessment

In an investigation by Patajac (2011), the effects of the introduction of a BI system were simulated on the specific categories, which influence the income and the profit of a production and wholesale organisation, respectively. In both simulations, the results demonstrated that the BI investment brought about improvements in business results, where the basic return on investment of the systems was estimated at 21.5% for the production organisation and 79.5% for the wholesale organisation, a difference due – in all probability – to the amount of data used for decision-making in each type of organisation.

In the light of the above simulation, it is evident that current methods of return-on-investment calculations cannot be used alone to evaluate BI systems. Therefore, Saaty (1998) recommended a move away from evaluation methods that are financially based to other techniques that can incorporate the value of intangibles as well (Gibson and Arnott, 2002b). Irani and Love (2001) argued that due to the number of strategic benefits, BI investments cannot be evaluated by using traditional methods, as demonstrated by the model below.

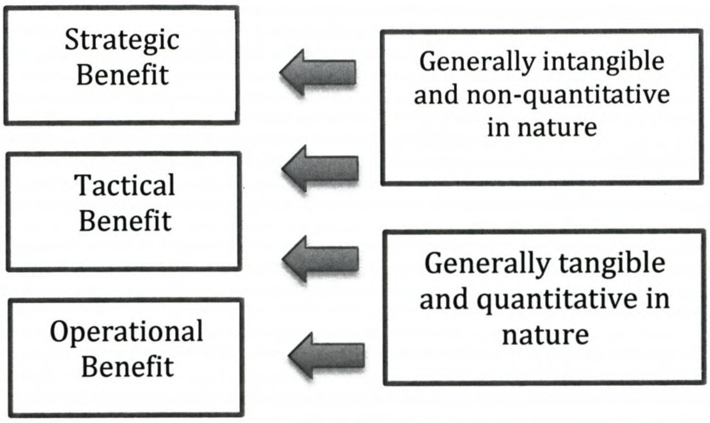


Figure 3.2 - Nature of Strategic, Tactical and Operational Benefits (Irani and Love, 2001)

The model builds on the model by Hares and Royle (1994) that demonstrates the benefits can be both tangible and intangible – depending on whether the benefit is operational, tactical or strategic. Therefore, it is not enough to merely calculate the tangible benefits, since the intangible benefits play just as significant a role. Based on this, Murphy and Simon (2002) suggested an adaptation of the procedure specified by Hares and Royle (1994) to quantify intangible benefits by doing the following:

- Step 1: The identification of the benefit to be quantified.
- Step 2: Make the intangible benefits measurable by means of re-expressing the benefits of the investment in more measurable terms.
- Step 3. Finally, the last step is to then predict the benefit in physical terms.

While the above method is an early attempt at estimating the value of intangible benefits, it is still heavily reliant on the quantification of these benefits.

3.4.3. Accuracy of Data Assessment

Wagner and Zubey (2007), on the other hand, suggest a framework based on the accuracy of the data, which include source data, business rules and governance, relevancy of information – which requires the alignment to strategic operations and goals – and timelines of information in terms of delivery to the right end-user, when this is required in the decision-making process.

Similarly, Reilly (1998) produced three techniques to assess proprietary technology, specifically the market approach, the cost approach, and the income approach. The market approach entails doing an investigation into comparable projects in other organisations, and assessing these projects, based on their costs and benefits. This allows the organisation to learn from past lessons experienced in these comparable projects, while remaining aware that the same impact may not be relevant to their own environment.

The cost approach uses a substitution methodology, where costs and benefits are derived by looking at other technologies, processes and resources, and using these as a basis of comparison. Finally, the income approach aims to establish the additional income or lower costs incurred with the advent of the BI system; and it does this by obtaining estimates from management on the costs and benefits that are anticipated. Each approach is, however, dependent on the business context in which it is applied.

From a study conducted by Ranjan (2008), a list of those factors that highlight the importance of BI for organisations across various industries was derived. These included the use of BI tools for analytics, the ability to identify key consumers and loyalty using available data, the click-streaming of data to improve e-commerce strategies, timely product-defect detection, the identification of criminal activities, identifying growth potentials and consumer demand, and understanding consumer-switching patterns, amongst others.

This study shows that the benefits of BI can be huge – regardless of industry; however, it is still very much dependent on the correct usage of the information available.

3.4.4. Cost-based Assessment

Lönnqvist and Pirttimäki (2006) maintain that although the most important question in the assessment of BI value is the cost of the application compared to the benefits derived from the it, the measurement of benefit is not merely a question of cost, but also the inclusion of effects in the organisation that the BI system was predicted to create post-implementation, such as improved quality and timeliness of the new information (Hannula and Pirttimäki, 2003; Nelke, 1998). However, they also note that while the non-financial effects would eventually lead to financial outcomes, such as cost savings, there would be a time lag between the implementation of the system and the financial gain, which adds to the difficulty of the value assessment (Lönnqvist and Pirttimäki, 2006).

Despite the difficulties, examples do exist of past attempts to estimate the value of intelligence. Davison (2001) is one such example, where the Competitor Intelligence Measurement Model (CIMM) was created, which allows for the theoretical calculation of return on competitor-intelligence investments (ROCII); and this could possibly be used in a BI situation as well. The basis of ROCII is the equation:

ROCII = ((CI outputs – CI inputs) / CI inputs)
Where CI= Competitive Information

This allows for the evaluation of individual intelligence projects with the inputs seen as the cost of implementing the project; while the outputs are derived as the fulfilment of the project objectives and the satisfaction of the organisation with the output. This model, while taking into account intangibles, does so, still based on cost; and therefore, it cannot account for those intangibles that cannot be reflected as a financial value.

Herring (1996) highlighted four key measures of the effectiveness of intelligence investments, namely: time savings, cost savings, cost avoidance, and revenue enhancement. Sawka (2000) built on this by stating that the evaluation of a BI investment must be done, in accordance with a specific decision or action, to which it has contributed, in order to accurately assess the benefit or the detriment that the decision to implement has had. In line with the findings of Herring (1996), Sawka (2000) stated that four factors can be used for this evaluation. These factors are the role of BI in the avoidance of unnecessary costs such as product-development costs, as well as the assumption that organisational decisions that were based on good intelligence may lead to improved business revenues.

Sawka (2000) maintained that BI investments can help in the improvement of resource-allocation decisions, which in turn can maximise the investments for the most profitable scenarios, as well as the measurable link between the BI investment and corporate performance.

An example given by Sawka (2000) is that a pharmaceutical company saw as much as $600 million in increased revenues from effective marketing strategies designed through better insights. Alternatively, another method to understand the effect of BI investments would be to have a subjective measure of effectiveness, based on the concept of perceived consumer satisfaction (Davison, 2001).

Based on the assumptions made in these findings, it now stands to reason that a conceptual model embodying the key factors behind these financial assumptions can be created.

3.4.5. Resource-based Assessment

Ramakrishnan and others (2012) state that the three main reasons for an organisation to implement a BI system are: to gain better insight into its business processes, operations and strategies; while also being able to achieve a single consistent view of business information, as well as enabling organisational transformation. In the first instance, organisations require BI systems to query and analyse transactional information emanating from data-intensive applications, such as Enterprise-Resource Planning (ERP) systems, so that a better understanding of trends and dependencies impacting the business would be available to decision-makers.

Organisation-wide data are constantly changing, as companies expand, and merge; consequently, being able to obtain a single view of all pertinent business information is key for strategic decision-making and efficient management, which in turn helps to achieve high quality data and better data analysis. This also helps in the development of new applications, in order to save time for users, and to facilitate communication between key stakeholders with access to the same information, while also enabling adaptations and changes to the business models to take advantage of market changes (Ramakrishnan et al., 2012a).

In the study conducted by Ramakrishnan and others (2012), it was found that internal pressures lead organisations to implement BI solutions, in order to achieve internal consistency, which in turn, would lead to the adoption of a comprehensive data-collection strategy, which is also linked to organisational transformation. The study results point to a positive relationship between institutional pressures in the adoption of BI and the implementation needed for consistency; while also finding a positive relationship between BI implementation and organisational transformation, due to a comprehensive data-collection strategy.

However, the study did not find a direct link between competitive (or external) pressure and BI implementations, which may be due to a lack of strategic alignment between the business and the IS department. The lack of strategic alignment may occur from both the IS and business perspectives, where the business is not aware of the ability to make use of Business Intelligence systems for competitive analysis, while the IS department is not equipped with sufficient business requirements to understand the business needs in terms of competitor intelligence information.

3.5. Key factors of BI Value

3.5.1. Information Quality

The assessment of the value of information is a key factor in understanding the value of BI systems. According to Petter and others (2008), little consensus on the value add of BI systems is available; while De Voe and Neal (2005) maintain that the value of BI systems is the ability to get the right information to the right user at the right time. Thierauf (2001) states that organisations with BI systems implemented successfully experience improved access to a number of factors that are not easily measurable in a non-BI environment, such as customer activities, marketplace trends, supply-chain issues and other key performance indicators.

Pranjic and others (2011) used the findings of a study conducted on the usefulness of data in the decision-making process in the following diagram. The vertical (x) axis represents the value of information; while the horizontal (y) axis represents the availability of the data.

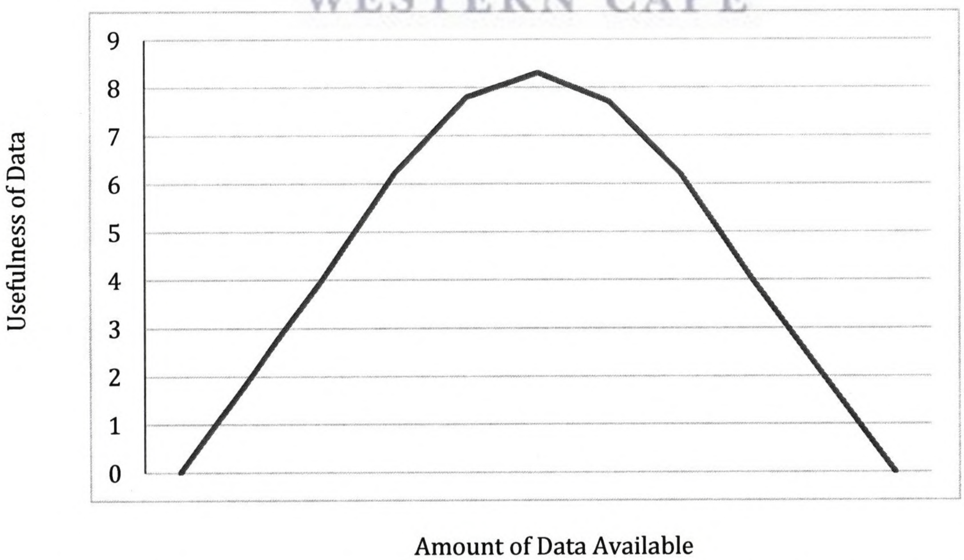


Figure 3.3 - Usefulness of data vs the amount of available data. Adapted from Pranjic and others (2011)

The diagram above shows that, as the amount of available data increases, the usefulness reaches an optimum point – before it begins to decrease. This implies that having more information is not necessarily optimal; as the usefulness of that information increases as the subject reaches a point of information overload.

Pranjic and others (2011) also focused on competitor intelligence as a part of BI, stating that current competitor activities and the anticipations of future activities of the competition are key in the decision-making process, with legal sources that are largely dispersed and in different formats, such as publications, the daily press, interviews, presentations and participation at fairs and exhibitions, amongst others.

An article in Magazine Business Week (2011) stated that organisations making use of mature intelligence systems and methods have an estimated 20% faster growth of income than their competitors, who are not making use of BI systems. In terms of benefits, not only the increase of income is identified as a benefit, but also factors, such as the prevention of loss, customer retention and competitive edge.

Pranjic and others (2011) demonstrated that "garbage in" in terms of bad data leads to "garbage out" in terms of bad decisions. Of the total number of employees surveyed, 78% believed that good data are crucial, in order to make the strategic right decision; while 79% believed that good data are critical for operative decisions. The study also demonstrated that only 10% of correspondents believed that they had all the necessary information when needed; while 46% stated that they had had trouble searching through such large amounts of data to find the right data to make a decision; and 56% of the correspondents were concerned that there is the possibility of making the wrong business decision, due to incorrect and incomplete data.

While Popovič and others (2005) viewed it as limiting the potential value of a BI implementation, improved information quality is seen as the most tangible benefit Watson and others (2002), with other outcomes, such as improved processes, better decision-making, and increased market share a subset of improved information quality. The use of BI to adapt business-process execution is referred to as BI system (BIS) absorbability, as depicted in the diagram below (Popovič, 2010).

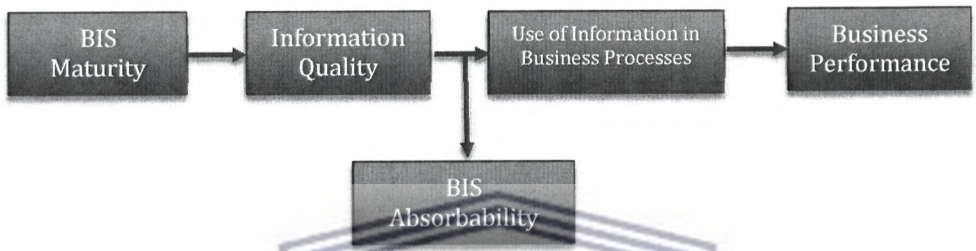


Figure 3.4 - Conceptual model for researching business value of BIS (Popovič, 2010)

According to the BIS Absorbability model, maturity in BIS is key; as this leads to Information Quality, which supplies usable information in the organisation and its processes, which impact directly on business performance. Information quality is highlighted in the model; as without it, the entire model does not hold ground.

Business maturity can be measured, based on the level of which BI technology is present in an organisation and its usage, as depicted in the table below.

Table 3.1 - Six-stage Maturity Model (TDWI, 2005)

Stage	Architecture	Analytics	
1 Parental	Reporting	Paper Report	Insight
2 Infant	Spreadmarts	Briefing Book	
3 Child	Data Marts	Interactive Report	
4 Teenager	Data Warehousing	Dashboard	Action
5 Adult	Enterprise DW	Cascading Scorecards	
6 Sage	Analytical Services	Embedded BI	

While the stages presented above are more relatable to popular reading pieces, they are in line with the definitions presented in other ICT models. As the organisation progresses down the stages, so too does their architecture – from being merely paper reports to truly analytical services that move the organisation from information that provides insight into actionable information.

Matthews (2013) quotes Saracevic and Kantor (1997), where the preferred approach to establishing the value of an entity was not the philosophical dimensions of value, but rather a more pragmatic approach, as taken by economists. The economist approach of value entails that what contributes to wealth is based on Smith's (1776) distinction between "value in-exchange" and "value-in-use".

These conditions are considered as the foundational principles of economics.

The value-in-exchange theory refers to a scenario where money is exchanged for products or services – at the price indicated by the product's or service's value. Value-in-use is also referred to as the "utility theory", where value is derived from what the user defines as value; and it entails the associated demand, need and want, usefulness, satisfaction, amongst others. In this case, the value of the information would be separate from its effect and/or benefits. In both situations, value is assigned, based on what the individual attributes to the good or service, based on their information or knowledge.

From an economic perspective, information is defined as a phenomenon that reduces uncertainty, and is measured in terms of supply and demand, using exchange rates; while accountants value it in terms of costs and benefits. Behavioural scientists are more interested in the cognitive and behavioural changes brought about by the changes in information levels (Matthews, 2013).

Matthews (2013) goes on to define the main characteristics that define or influence the value of information as its ability to reduce uncertainty, increase knowledge and reduce ambiguity. The data also need to be clear and nonredundant, system dependent, able to be shared, timely, able to be compressed, presentable, stable, relevant, leakable and substitutable. Based on these, it is clear that information in itself is a key factor in the assessment of value for an organisation from an accessibility, usability and quality perspective.

By combining the concepts of value and information, new challenges are created; since it is assumed that the receiver has value for that information. Furthermore, the information must have an expected value-in-use, in order to interest the user, who then decides whether the received information has any value (Popovič and Jaklic 2010). If a link between the information and its role or purpose can be established in relation to a specific task or output, the value can be more easily identified.

One of the key roles of BI systems is to reduce the gap between the operational data that are gathered and the quality information that is the output in an organisation, in order to make strategic and tactical decisions. However, the more information that is available, the slower the number of decisions made compared to the appropriate amount of information required for the decision. While intuitions still play a role in business decisions, it has become a more supplementary element, with structured fact-based decision-making taking precedence (Popovič and Jaklic 2010).

Popovič and Jaklic (2010) further define the different forms of information gaps – all of which lead to poor information quality – as the location of the data, the appropriateness thereof, the availability, the format, the usability and the sensitivity. These gaps also need to be taken into account, when assessing the value of information.

Despite the differences in research contexts, goals and methods, most researchers are in consensus regarding the criteria needed to describe good quality information (Popovič and Jaklic 2010). A number of conceptual frameworks and simple lists of information quality criteria exist in the current literature – from a management, communication, and IT perspective (Davenport, 1997; Eppler, 1997; Kahn et al.., 2002; Lesca and Lesca, 1995; Morris et al., 1996). Eppler (2003) defines an information quality framework, as one providing a systematic and concise set of information, which consists of evaluation criteria, a method to solve information quality issues, and the building blocks for information-quality measurement and benchmarking.

Other definitions of information quality include (Huang et al.., 1999) the definition as fit-for-use information in relation to its consumers; while (Kahn et al., 2002) describe information quality as the ability of information to either meet or exceed user expectations. Lesca and Lesca (1995) defined information quality as being highly valued to its users; while much earlier studies include that of Grotz-Martin's (1976) information quality study and its effects on decision-processes and that of Deming (1986) detailing 14 information quality factors for management to transform business effectiveness.

Other studies (Crump, 2002; English, 1999), Ferguson & Lim, 2001); Lillrank, 2003) look at information quality from a number of perspectives including legal studies, pedagogy, medicine, accounting and rhetoric. Corte Real et al.., (2014) investigate the linkages between knowledge management and dynamic capabilities impacting competitive value – and thus also the effect on company performance. Despite the difference in field, in which these studies have been conducted, the value is dependent on the usability by the end-user of that information, which Huang and others (1999) summarise as the value inherent in the use of the information.

The table below is a summary prepared by Eppler (2003) and reiterated by Friberg and others (2011) of the most appropriate information quality criteria:

Table 3.2 - Information quality criteria (Eppler, 2003; Friberg et al., 2011)

	Criterion name	Description
Quality of Information Content	Comprehensiveness	Is the scope of information adequate? (Not too much, nor too little?)
	Conciseness	Is the information to-the-point, void of unnecessary elements?
	Clarity	Is the information understandable or comprehensible to the target group?
	Correctness	Is the information free of distortion, bias, or error?
	Accuracy	Is the information precise enough and close enough to reality?
	Consistency	Is the information free of contradictions or conventional breaks?
	Applicability	Can the information be directly applied? Is it useful?
	Timeliness	Is the information processed and delivered rapidly without delays?
	Believability	Is the information believable?
	Completeness	Is the information complete?
	Objectivity	Is the information objective?
	Relevance	Is the information relevant?
Quality of Information Access	Traceability	Is the background of the information visible (author, date etc.)?
	Maintainability	Can all of the information be organized and updated on an ongoing basis?
	Interactivity	Can the information process be adapted by the information consumer?
	Speed	Can the infrastructure match the user's working pace?
	Security	Is the information protected against loss or unauthorized access?
	Currency	Is the information up-to-date and not obsolete?
	Accessibility	Is there a continuous and unobstructed way to get to the information?
	Convenience	Does the information provision correspond to the user's needs and habits?
	Validity	Is the information valid?

Eppler (2003) demonstrates that the quality of information can be split into a content perspective with attributes that hinge on the actual make-up of the information, such as correctness and timeliness, and the quality of information from an access perspective, which is system-dependent, and determines the actual usage of the data.

Friberg and others (2011) cite believability, completeness, validity, objectivity and relevance to the above indicated criteria.

In order to add value via quality information Popovič and Jaklic (2010), the organisation must ask itself whether the access to the integrated data and the global view of a customer would assist the organisation to better understand the customers and to treat them differently; whether better information would lead to better negotiations with the suppliers; whether response times to market events would be shorter – due to faster access to information – and therefore lower business risk and increased potential of business opportunities; whether the number of users of quality information would increase if the proper formatting and access were in place, and whether it would have an impact on the structure of the organisation and/or the execution of the business processes? Would organisations, because of the complete information about suppliers, be able to negotiate better deals?

Only when these questions can be answered positively, can true business value be derived from a BI investment, as a result of increased information quality.

Williams (2003; 2004) states that in turn, the organisation would see improved business processes, better business-process management, supply-chain optimization, better retail processes, cross-selling and overall better management processes, as a result of implementing a BI solution – with the aim of increasing revenues and/or decreasing costs.

The diagram below represents the impact of BI on business performance.

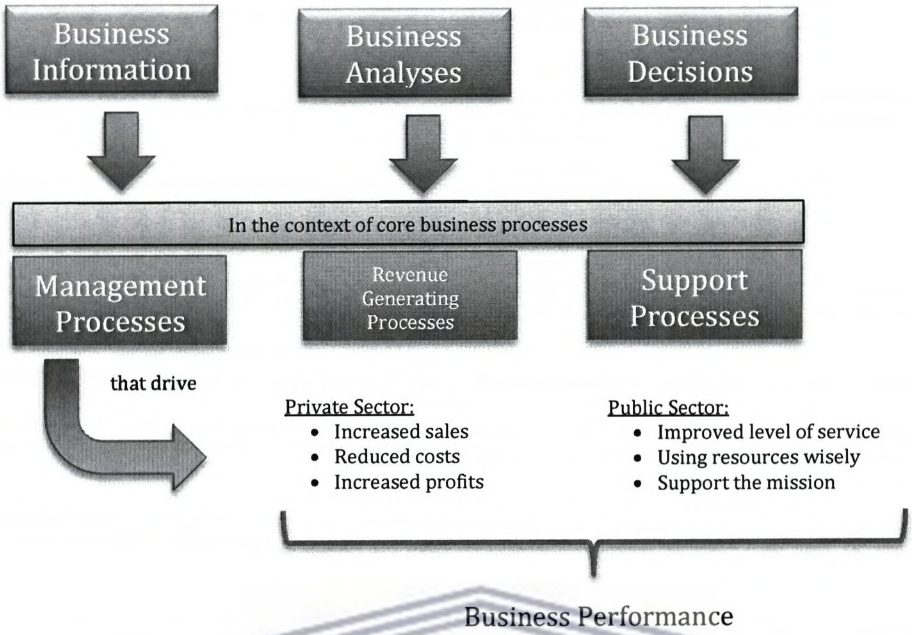


Figure 3.5 - Business Processes where BI can contribute to Business Performance (Williams and Williams, 2007)

Figure 3.5 demonstrates the areas, in which improved information quality impacts on business processes, business analyses and business decisions, which in turn, would impact management, revenue generating and support processes, respectively; while having a positive impact on the organisation's relationship with its external environment.

Popovič aand Jaklic (2010) further show that if this situation is in place, the benefits derived would include unburdening analytical users, and allowing them to focus on more complex analyses; less burden on information specialists to prepare information; as it is readily available to users, thus allowing the specialists to focus more on strategic tasks; less time would be wasted on data preparation and analysis on the side of information users; early identification of problems; support for planning at lower hierarchical levels; better data integration from disparate sources; better transactional system data quality - due to critical process points identification and a more flattened organisational structure.

The maturity of the organisation's BI can now be gauged – using the figure below.

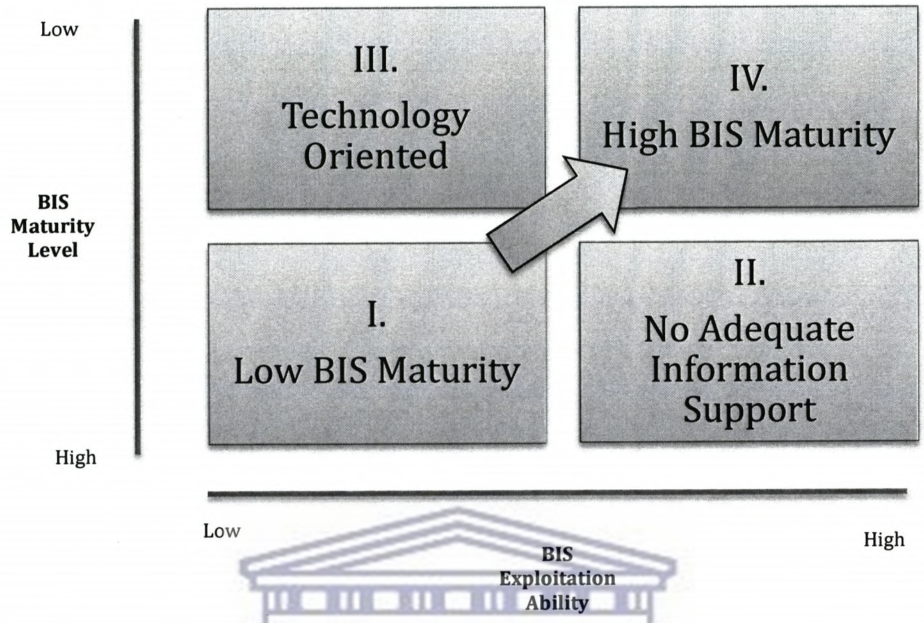


Figure 3.6 - BIS maturity quadrant (Williams and Thomann, 2004)

As the level of BI systems maturity increases, it can be compared with the ability of the organisation to exploit systems and technology to improve business performance.

As the BI maturity increases, so too does the business-value creation, as demonstrated in the graph below.

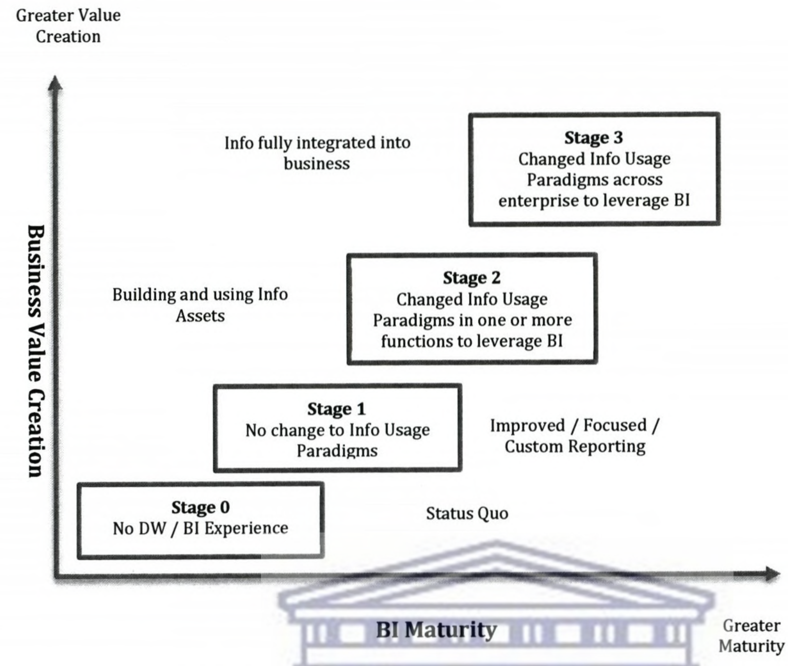


Figure 3.7 - BI maturity (Williams, 2006)

As an organisation progresses along the stages of maturity, so too does the usage of information available; as it becomes more widespread in the organisation, and thus increases business-value creation, as more quality information is integrated into the day-to-day business operations.

3.5.2. Impact on the Customer / Consumer

Another key factor discussed widely in the available literature is the impact that BI investments have on the organisation's customers and/or consumers. Williams (2003) shows that the improvement of operational processes, such as sales-campaign execution, customer-order processing, purchasing, and/or accounts payable processing can aid in the increase of revenues and/or the reduction of costs.

Gessner and Volonino (2005) demonstrate that by making use of a BI system, an organisation can leverage customer transactional and interaction data, in order to identify up-sell, cross-sell, and retention opportunities, thereby increasing value to the customer, while mitigating high attrition and defection. By doing so, the organisation can optimize customer value, with a payback that is both immediate and sustained. The diagram below details the optimal customer lifecycle.

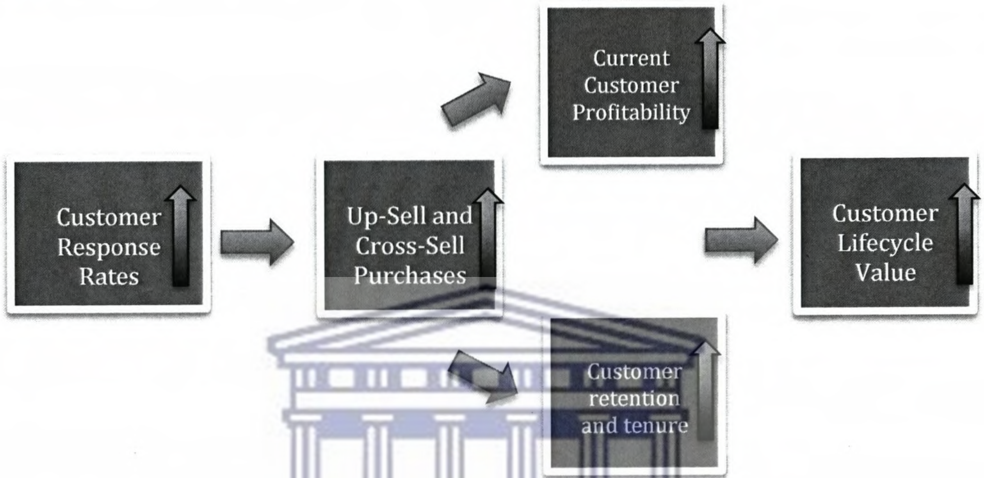


Figure 3.8 - Customer Lifecycle. Adapted from Gessner and Volonino (2005)

The above Model of Customer-Lifetime Value is dependent on the timing of offers to the customer and the maintenance of loyalty that decreases attrition levels. A positive return on a BI investment can be calculated using the response received from customers for an organisational offer.

Noyes (2002) shows that when an organisation responds quickly to their action, customers are more likely to purchase additional products or services, and remain loyal for a longer period of time. Heygate (2002) defines the "next-best activity" as a set of instructions linking a marketing strategy with customer insight in terms of operational sales and service, which can be used proactively by translating insights into strategy, or even better by using historic insights to proactively initiate customer actions.

In other words, all activities in the customer's lifecycle must be monitored and acted upon, in order to ensure that the value throughout the lifecycle is achieved.

Gessner and Volonino (2005) suggest that this can be done through customer-relationship management (CRM) and learning management, which is the ability to learn through assessing customer events and continuous improvement.

Through their study, Gessner and Volonino (2005) demonstrated that with the advent of BI solutions, not only can customer profitability be increased; but customer attrition levels can also be decreased, as the investment enables management to identify up-sell and cross-sell opportunities, and to intervene in the customer lifecycle, where necessary.

By responding rapidly to customer events with appropriate offers or interventions, changes in customer value across the organisation's customer base are linked to BI investments and profits, with the conclusion that decisions to fund BI investments may be key in optimizing customer lifetime value (Gessner and Volonino, 2005).

3.5.3. Accessing information – a systems perspective

From a technology perspective, a BI system can be seen as a set of tools, technologies and programmed products, used in unison – to collate and analyse data, which are then made available *via* a storage area, such as a data warehouse. A data warehouse can be described as an integrated, subject-oriented, time-variant and non-volatile grouping of data that differs from conventional online transactional processing (OLTP) databases (Inmon, 2005).

While seen as complex, it is necessary to use a storage area, such as a data warehouse, in order to gain a single integrated view of all the data sourced from disparate sources. As described by Wixom and Watson (2013), a significant aspect of deriving benefits from a BI solution is the data quality and the system quality relationships. The quality of the data-storage solution and its data play a key role in this relationship.

Eckerson (2003) highlights that a number of different BI tools are available as BI instruments in a diverse field; and there is no "one size fits all" solution. Different vendor solutions may even be used in one organisation, as they meet different organisational requirements (Howson, 2004).

In the current literature, many academics study the impact of intelligence systems (Guimares et al. 1992; Rainer and Watson, 1995). The value of implementing such a system lies in the success or failure to support key processes within the organisation (Ross et. al. 1996). A commonly used measure of performance for system quality includes system flexibility, integration capability, response time and reliability (DeLone and McLean, 1992).

From the perspective of data warehousing (or data marts), as the *de facto* storage area in any organisation, high quality data and BI systems improve the provision of data to reporting tools as part of the decision-making process (Wixom and Watson 2013). This demonstrates the need for a data-storage area that contains high-quality data, can flexibly respond to the users' requests, and can integrate the data, as required by users, in order to create value from the investment.

According to Popovič and Jaklic (2010), an organisation's level of BI-system maturity is directly correlated to the evolution of organizations' BI system access capabilities over a period of time. The Data Warehousing Institute ('TDWI') states that a maturity model for BI systems demonstrates how BI systems can evolve from low-value, cost-centred tools to high-value, strategic utilities that drive performance (TDWI, 2005). This implies that as the accessibility of data is improved, the BI systems maturity within that organisation naturally increases.

Yeoh and Koronios (2010) break down the critical success factors for the implementation of BI systems into three key dimensions, namely: organisational; process; and technological. From an organisational dimension, it is key to have management buy-in and support, as well as a clear vision for BI in the organisation with its case being driven by the business.

From a process dimension, it is key that champions are identified within the business to drive the implementation, as well as a business-driven development approach that is iterative. Finally, from a technological perspective, it is key once again that the system be driven by the business, and that the technical framework is flexible and scalable, with sustainable data integrity and quality (Yeoh and Koronios 2010).

3.5.4. BI Culture and Capabilities – A Human Perspective

BI solutions facilitate an organisation's information-processing capacity (Gallegos, 1999; Nelson et al., 2005). This is done by the combining of data collection, data storage, and knowledge management with analytical tools, in order for management to use complex information to make effective business decisions (Negash, 2004).

According to Popovič and others (2012), the presence of an analytical decision-making culture within the organisation is just as critical as information quality and access to information, to ensure BI maturity and successful BI investments. The figure below demonstrates the BIS (BI System) success model.

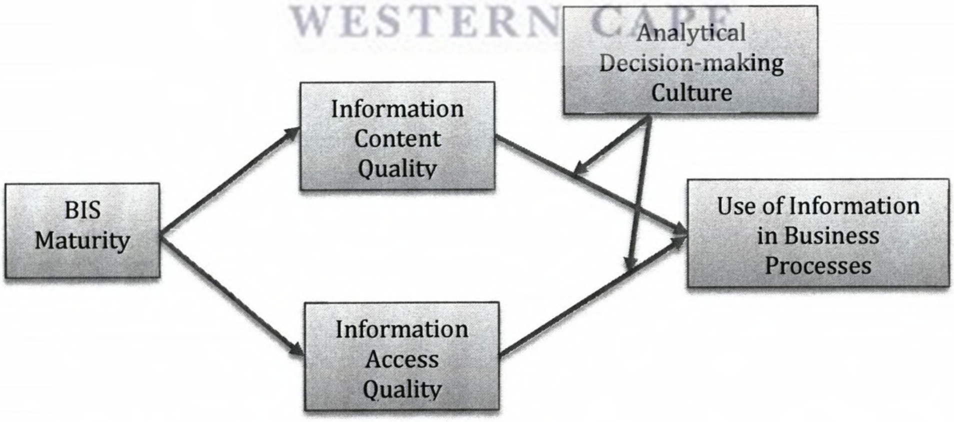


Figure 3.9 - The BIS Success Model (Popovič et al. 2012)

The BIS success model shows that, in order to obtain BIS maturity within an organisation, there needs to be a combination of Information Content and Access Quality, together with an Analytical Decision-making culture, in order for the systems to add value to the Business Processes.

While organisations can implement BI systems successfully from a technological perspective, the anticipated benefits may not be immediately realised, because of neglect of the usage factor of the system (Sharma and others, 2003). Popovič et al. (2012) demonstrates in their study that the presence of an analytical decision-making culture would directly and positively impact the use of information on organisational business processes.

BI capabilities can be broken down into two distinct parts, namely: technological (e.g. data sources and data reliability); and organisational, which are those that impact the usage of BI in the organisation, for example, flexibility and the risk-taking level of the organisation (Feeney and Willcocks, 1998; Bharadwaj et al., 1999).

Gibson and others (2011a) identify three models that can explain the culture of information accessibility and usage in an organisation. The first model is Information Dictatorship, where the data are held by a small number of employees, and are not – or are barely – disseminated to the rest of the organisation. According to this model, no linkage of information across business areas exists. Decision-making amongst employees is not promoted. The second model is Information Anarchy, where very little control over the dissemination of the information exists. Information Anarchy normally entails a situation where stand-alone databases lie in different departments in the organisation, instead of being centralised.

The state of anarchy leads to a lack of interoperability of information solutions and a breakdown in communication across departments; since they use different sets of data. Organisational memory, together with organisational intelligence, is limited to inconsistent data spread across the organisation. The final model is Information Democracy, where relevant information is available to employees, according to their informational needs from a centralised data-storage area. The centralisation of data storage allows for the correlation of information, as well as timeous and easy access to information that is clearly presentable, and that can be used to attain organisational goals – with a greater number of employees being involved in the decision-making process – where their skills are required.

The model of information sharing and usage within an organisation can also be used as a gauge, as to the value that an organisation associates with its BI system.

3.5.5. Linking BI to Corporate Performance

Thus far, little has been found empirically to link the intelligence activities of an organisation to its corporate performance (Hughes, 2005). Most current literature has either anecdotal accounts, or case studies conducted in developed countries (Pirttimäki, 2007; Smith and Kossou, 2008; Subramanian and Ishak, 1998).

Ranjan (2008) states that the success of BI does not lie in the volume of usage or paper generated, but in its impact on the business, and in the improvements in key areas that can be attributed to its implementation. Authors, such as Kudyba and Diwan (2002) Carr (2003) and Hoblitzell (2002), have asserted that business strategies that create increasing value over time are those with a future-focused orientation for achieving the long-term goals of the organisation.

Williams (2003) states that, in order to derive value from BI investments, the organisation must first identify the strategic drivers of the competitive environment or organisational environment and the related organisational goals. Only then, can the key business questions be answered, in order to plan, budget, control, monitor, measure, assess, and improve organisational performance in relation to the strategic goals.

Once this has been done, it is possible to determine the tools, methods, and analytical frameworks to support the execution of business processes, as well as the management of organisational performance, and the following of well-established technical procedures for identifying, acquiring, integrating, staging, and delivering data and the information required (Williams, 2003).

According to Bakos and Treacy (1986), the business value of systems can be looked at from two perspectives, namely: Business-Process Performance, which includes operational efficiency enhancement in business processes that are supported by BI systems, such as cost-reduction and productivity-enhancement. The operational efficiency can be translated into organisational performance, which aggregates the performance enabled by BI across the organisation into metrics used to capture organisational performance, such as ROI and sales growth, each of which are indicators of organisational-objective realisation and competitive advantage.

Elbashir and Collier and others (2008) highlight in their study the three main factors in which organisational metrics can be grouped, namely: business supplier/relation benefits, such as reductions in transaction costs and better inventory management, internal process-efficiency benefits, such as enhanced staff productivity, and the reduction of operational costs and customer-intelligence benefits, which include reduced speed to market, meeting customer demand, and customer segmentation.

The table below lists the key business metrics to which BI speaks, according to (Gibson et al., 2011a).

Table 3.3 - Key business metrics related to BI (Pranjic, 2011)

Key Metrics	Key business measure related to BI
Market share	Identify the reasons why market share is not satisfactory;
Profit	Better understand the factors influencing profit;
Costs	Identify business areas, where unacceptable costs occur;
Sales	Gain an accurate view of sale and/or distribution costs, per channel, per customer,

	per transaction, per day;
Performance	Recognize business areas of high performance;
Market Opportunities	Identify market opportunities;
KPIs	Identify the key performance indicators [KPIs] to measure capability;
Measures	Calculate sales commissions, number of sales closed, highlight good and poor performers;
Strategies	Track whether strategies for certain markets or customers are working and driving business value;
Insight	Get instant insight into the exact profit by the company of each sale (e.g. Daughter Company);
Improvement	Improvement of the planning and important decision-making processes
Opportunities and threats	Identification of internal opportunities and threats;
Decision-making	Increase in manoeuvring space for decision-making;
Risk	Minimizing the risk of a business decision.

The table shows that the main areas impacted by BI within a business are those involving performance: both internally and externally – the factors that impact the organisation's bottom line, as well as an understanding of the market and customers, and the proactive actions that the organisation can take, based on this information.

The final component of business performance management is from a competitor-intelligence perspective. In a study conducted by Adidam and others (2012), it was determined that it is key to monitor the general industry and competitors, as well as to identify competitor vulnerabilities, and to review the effectiveness of organisational reactions to competitor actions, and vice versa. Pranjic and others (2011) found that by combining the intelligence of internal practices with the external environment, organisations were able to do a better analysis of the current organisational position, and to have a better understanding of the factors contributing to that position, as well as a better understanding of the set trends, and an ability to detect new trends that could positively or negatively influence the organisation.

In a study conducted by the Society of Strategic and Competitive Intelligence Professionals, it was demonstrated that organisations which practised a higher level of competitor intelligence were able to increase their business performance significantly more than those organisations not doing so (Pranjic et al. 2011b). Furthermore, it was found that companies that used a large amount of competitor intelligence had a 37% higher level of product quality, a 68% increase in business performance, a 36% higher level of strategic planning quality, a 48% increase in business performance, a 50% higher level of market knowledge, and a 36% increase in business performance.

The table below highlights the main benefits of using competitive intelligence.

Table 3.4 - Benefits of using Competitive Intelligence (Pranjic, 2011)

Benefits of using Competitive Intelligence
Detection of profitable market niches
Detection of competition's strengths and weaknesses
Detection of warning signals in case of political instability
Detection of recession signals
Detection of new administrative and legal possibilities and limitations
Detection of new or potential competition
Enhancement of reliability of prognoses of leading forces in a business environment

Decoding of competition's intentions
Identifying new business opportunities / growth opportunities before they are obvious
Improving the organisation's ability to anticipate surprises
Improving managerial analytical skills
Faster and more targeted response to market changes / reduced reaction time
Identifying critical points of vulnerability
Early warning for competitive threats
Identifying blind spots
Synchronizing information from all providers
Conduct accurate marketplace assessments for tactical moves
Improved quality in strategic and tactical planning
An increased understanding of customers current and future needs
Organisational learning and increased sharing of knowledge

As demonstrated by the table above, the main advantage of using Competitive Intelligence is a thorough understanding of the external environment, in which the organisation operates. This environment includes, amongst others: competitors, economic indicators, political and social situations, in order to enable the organisation to plan and act on this information.

3.6. Conclusion

The table below provides a guideline, based on the studies that have investigated the successful implementation of BI systems (Biere, 2003; Cates and others, 2005; Miller et al., 2006).

Table 3.5 - Successful BI Implementation Framework (Ranjan, 2008)

Organisational Requirements	• Corporate mission and vision statement. • Reasons for embracing a centralized, managed approach to BI. • Justification of BI acquisitions, using the following processes: o Application-specific use; o End-user surveys and requests; and o IT decisions. • Tracking and measuring the BI efforts and BI support structure. • Role of individual departments and functional areas in selecting and maintaining their own BI strategies, tools, databases, etc.
Standards	• Details of a thorough end-user segmentation and evaluation methodology. • Details of a standard for BI tools: education and support.
	• Details of end-user's requirements for the current tools. • Details of corporate infrastructure (user-group, newsletter, etc.) for BI and their processes. • Documented and approved BI strategy for external and internal users.

	• Details of percentages in time and expense for BI activities.
Technological	• Details of enterprise-wide database. • Database strategy and corporate strategy for BI for thin-client access. • Analytical tools and their architectural requirements. • Details of BI-database architectures, data warehouse, data marts, federated databases. • (Multi-source) data access, OLAP, and others. • Details of BI database-decisions, based on: o Technology (features, functions, etc.); o Platform, regardless of the vendor's solutions; o BI-specific functionality (specific analytical functions); o IT preferences and standards, cost, etc. • Details of vendors: vendor applications and packages. • Details of BI budget, including software costs, hardware upgrades, user training and education, outside consulting services (if any). • Details of available BI tools and their impact on existing processes.
Cultural and Other Issues	• Details of production libraries and production databases, the daily, weekly, and monthly extract/transform/load (ETL) processes on the job scheduler. • Details of regularly scheduled application-report programmes, scheduled metadata repository programmes.

	• Concerns of operations staff towards quality assurance (QA) test results. • Details of security measures, user authentication services, database maintenance, back-up and recovery procedure, and disaster-recovery procedure. • Concerns of the business people receiving training.

From the table above, it is clear that only when the organisational, technological and cultural needs related to the implementation of a BI system are met can that system add value to an organisation. This includes not only the system availability and reliability, but also the quality of data and information, as well as the capability to use this information effectively. Therefore, the key factors that can be extracted from the literature review conducted are:

- Information Quality (3.5.1)
- Customer / Consumer Impact (3.5.2)
- Information Accessibility (3.5.3)
- Culture and Capabilities (3.5.4)
- Performance Management (3.5.5)

This chapter has highlighted and delved into the evaluation of BI systems, investigating the difficulties encountered with evaluations, previous studies conducted, and the findings from research conducted into the key factors that impact the value of BI systems. The next chapter looks at the research methodology used in this study, based on the factors identified in the literature review.

4. Theoretical Frameworks of BI Value

4.1. Introduction

The main objective of this study is to understand the key factors that impact on the value of BI Systems, and to test these factors empirically. In order to conduct these tests, a research method using specific research instruments was built. This chapter explores the existing methodologies and frameworks available – before specifying a proposed conceptual model to analyse the factors identified in the literature study.

4.2. Assessment of current available frameworks

There are currently a number of well-established methods to assess the benefit of operational systems where straightforward efficiency benefits do already exist. However, a problem lies in the evaluation of intangible benefits from systems, such as BI that are used for strategic purposes; since such benefits are difficult to assign to a single factor or arduous to identify in the organisation's financials (Gibson and Arnott, 2002). Many academic attempts have been made to classify intangible benefits by using frameworks and models: either financially based or subjectively based (Gibson and Arnott, 2002).
Aruldoss and others (2014) add to the findings of Gibson and Arnott (2004) by investigating the different available methods available that can be used to evaluate BI systems. In order to conduct the evaluation, Aruldoss and others (2014) used 34 criteria, such as information access and quality; and they applied the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) technique (Rouhani and Asgari, 2012).

Below is a summary table of the key evaluation techniques of intangible benefits, as identified by Gibson and Arnott (2002) and Aruldoss and others (2014).

Table 4.1 - Evaluation techniques Gibson and Arnott (2002) and Aruldoss and others (2014)

Evaluation Technique	Author/s	Research Type	Focus	Measures
Process Model with 6 critical factors	Counihan and others (2002)	Multiple Case Study (4 firms)	Data Warehousing (DW)	Intangible, identified using critical factors.
Value Analysis	Keen (1981)	Conceptual	Decision Support System (DSS)	Tangible and intangible. Intangibles made visible through the use of prototyping.
Total Cost Analysis	Tayyari and Kroll (1990)	Conceptual	Conceptual Computer Integrated Manufacturing (CIM)	Intangibles quantified using surrogate indicators.
Combination of Net Present Value (NPV) and Discussion with Personnel	Anandarajan and Wen (1999)	Single Case Study	Computer Integrated Manufacturing (CIM)	Intangibles quantified using discussion with personnel.
Quantification Technique	Hares and Royle (1994)	Single Case Study example. Also in Murphy and Simon (2002)	General IT	Intangibles quantified into cash, using subjective measures.
Negotiation and Imputation	Remenyi (2000)	Conceptual	General IT	Intangibles quantified using subjective measures.

Information Economics	Parker and Benson (1988)	Conceptual	General IT	Tangible and some intangible
Multi-objective, Muli-criteria (MOMC)	Kenny and Raiffa (1976)	Conceptual	General	Tangible and Intangible. Intangible measured by rank and weight of individual preferences.
BI system usage – End User Computing Satisfaction	Hou (2012)	Case Study	General	BI system usage and individual performance
BI Systems comprehensive evaluation index system	Yan and others (2012)	Conceptual	BP Networks	Index of factors influencing value of BI systems
BI benchmark	Seng and Chiu (2011)	Conceptual	General	Computer-assisted benchmarking

Process Model: This is one of the later approaches to the evaluation of intangible benefits; the process model is made up of six critical factors, namely: Economics environment analysis; Information-intensity analysis; Commitment and sponsorship; the Approach to evaluation; the Time scale of benefits; and finally, the Appraisal techniques. The Process Model acknowledges the issue with evaluating strategic intelligence systems; since it is difficult to attribute benefits to a single factor and/or system; and it thus, makes use of the six factors identified to overcome the issue.

However, the model has not been tested sufficiently in a BI systems environment, in order to yield solid results, which limits its capability as a BI system-evaluation model.

Value Analysis: Keen (1981) introduced the concept of Value Analysis (VA) as an alternative to financial cost-benefit analysis; and it is still in use today to assess the value of strategic systems. VA addresses four key issues, namely: reliance on prototypes; an absence of cost-benefit analysis; the evolutionary nature of intelligence systems; and understanding the perceived benefits.

Value Analysis is seen as an alternative to cost-benefit analysis, where intangible variables are assigned a value, in order to be evaluated. A key component of Value Analysis is prototyping – on which this method is quite reliant. While this method does allow for the assigning of monetary values to intangibles, it also requires a value-estimation process that is seen to be quite time-consuming and costly. This method can also be biased, as the assigning of values can be subjective, as well as difficult, when attempting to assess modern BI systems; since this method was developed for the evaluation of Decision-Support Systems (DSS), which have evolved significantly over time – into the BI systems of today.

Total Cost Analysis: Total Cost Analysis works from the basis that it is almost impossible to assign monetary values to intangible IT project benefits and costs. As such, it makes use of surrogate or proxy indicators to evaluate these intangibles (Tayyari and Kroll, 1990). An example would be the change in employee morale, based on the implementation of a BI system that lightens their daily workload. Once the measures are identified, traditional financial calculations can then be run, such as return on investment (ROI) and net present value (NPV).

The key issue with this approach is that there is no clarity or consistency on how the proxies are to be selected and/or assigned.

Combination of Net-Present Value (NPV) and Discussion with Personnel (NPVP): NPVP is based on the finding that traditional accounting methods were not adequate to evaluate intangibles, as well as the fact that most methods available had descriptions of the intangibles that were too obscure. The NPVP method follows three steps, namely: the determination of tangible and intangible benefits; the determination of costs associated with different technologies; and finally, the identification of net present values. This method relies heavily on discussions with participants; and as such, it may be prone to bias and subjectivity – due to its reliance on the human factor (Anandarajan & Wen, 1999)

Quantification Technique: Hares and Royle (1994) presented the Quantification Technique, also known as "bridging-the-gap", as a formal mechanism to evaluate intangible benefits. This technique entails the identification of benefits, making them measurable, predicting the benefits in physical terms, and then assessing them in terms of the cash flow. This method relies extensively on the perception of the researcher, and is therefore subjective and can be debatable. This limits it as a BI systems evaluation technique; as due to the use of market surveys, it could leave many BI system implementations inapplicable.

Return on Management: The Return-on-Management method developed by Strassman (1990) measures performance, based on the value-addition to the organisation provided by management. This is calculated by equating the cost of managing the business to information costs; and it is then calculated both pre- and post-implementation, in order to gauge the contribution. The ROM method basic assumption is that information costs can be equated to the costs of managing an enterprise. A key issue identified with the ROM method is that it is difficult to differentiate between operational and management costs. It is assumed that for this reason, there has been a lack of use in industry from its inception (Willcocks, 1992), which negates its value as a method for the evaluation of BI systems.

Negotiation and imputation: Remenyi (2000) defined negotiation and imputation as methods to evaluate intangible benefits by querying managers, in order to assign a value to a specific resource, such as a report. This value is then attached to that resource. While this method places a monetary value on a resource, it is still highly subjective, which opens it to scrutiny as a method for BI system evaluation (Remenyi, 2000).

Information Economics: Information Economics (IE) was introduced by Parker and Benson (1998). It is an investment-feasibility model; and it is based on other traditional approaches (Willcocks, 2001). Value in the model is defined as the combination of enhanced returns on investment, business-domain assessment, and technology-domain assessment (Parker and Benson, 1998).
The model assesses the benefits based on six dimensions, namely: return on investment (ROI); strategic match; competitive advantage; strategic information; competitive response; and strategic-technological architectures (Parker and Benson, 1998). The Information Economics method is complex; as it requires the calculation of a traditional return on investment followed by value-linking, value-restructuring, value-acceleration, and innovation-valuation, in order to establish an 'enhanced' ROI figure (Parker and Benson, 1998). Information Economics can be time-consuming because of its complexity, as well as scoring methods that were found to be not statistically sound (Willcocks, 1994). This contributed to it falling out of favour, as an evaluation tool for BI systems.

Multi-objective, Muli-criteria (MOMC): MOMC attempts to evaluate a measure of utility that is provided by a specific system within an organisation. Utility evaluation is done by users and key stakeholders evaluating the system's usefulness, which is then ranked, and a weighting is applied. With a large group of stakeholders, the goal is to gauge the highest aggregate utility. MOMC is found to be most useful during large, complex projects; and it can accommodate for intangibles; but it does not account for return-on-investment calculations. The main shortcoming of MOMC is that it has not been significantly tested in a BI system environment, in order to assess whether it is a viable evaluation tool (Sylla and Wen, 2002).

BIS comprehensive evaluation index system (BISCEI): The objective of the BISCEI system is to help to accurately assess the BI system's benefits for organisations. In order to do so, four principles are followed to establish the system, namely: systematization; accuracy; independence; and finally, comparability. This model was developed specifically in systems where neural networks were employed; however, this model must still be generalised further (Yan et al.., 2012).

BI system usage – End-User Computing Satisfaction (EUCS): The EUCS model uses the basis that positive end-user computing satisfaction is directly correlated with BI system usage. The model comprises five factors, namely: content; accuracy; format; ease-of-use; and timeliness impacting system usage, which is made up of: frequency of system usage and duration of system usage (Hou, 2012). While this model is a good gauge to assess the value-addition of BI systems from a user perspective, it is limited, since it focuses only on the user, and not on the impact on the business as a larger component.

BI Benchmark Method: A computer-system benchmark is used in a controlled environment to assess two or more systems. Examples include: TREC, TPC, SPEC, SAP, Oracle, Microsoft, IBM, Wisconsin, AS3AP, OO1, OO7 and XOO7 standard benchmarks that are used to assess the system's performance. The BI Benchmark method establishes a benchmarking framework to use for the evaluation of BI systems. The model is limited in its effectiveness currently, as it is founded on basic constructs; and it has not been tested using complexity; and furthermore, it is prototype-dependent. This method is envisaged to be an effective method to assess the value of BI in future studies.

4.3. Technology-Acceptance Model used in the evaluation of BI Systems

Studies have demonstrated that the Technology-Acceptance Model (TAM) is the most cited technology-acceptance model used in the Information-Systems field (Lee, 2003). TAM has evolved from its original inception in 1986; and it continues to do so. The phases of evolution can be broken down into four areas, namely: introduction; validation; extension; and elaboration, as depicted in Figure 4.1 below.

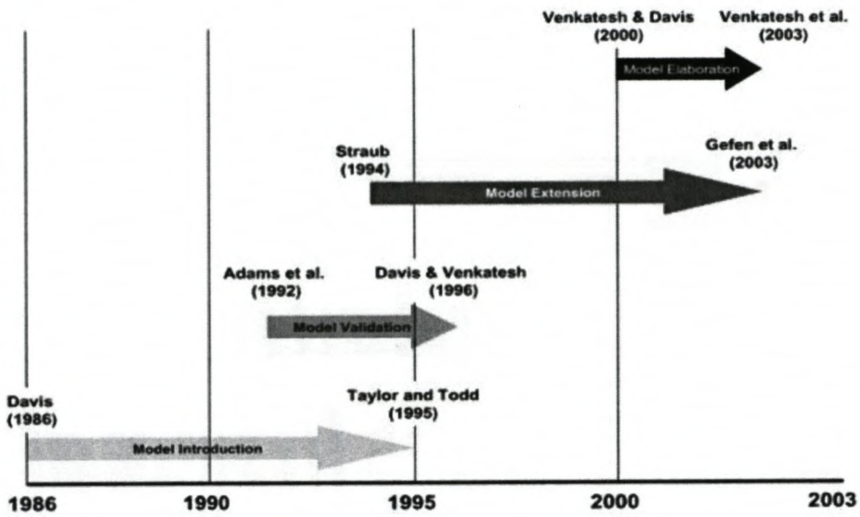


Figure 4.1 - Evolution of TAM (Lee, 2003)

The basis of the TAM is the action between Perceived Usefulness, Perceived Ease-of-Use, Attitude towards Using, and the Behavioural Intention to Use, which connects into the variable Actual System Use (Opitz and others 2012). Perceived Usefulness is seen as the probable chance of a prospective user's performance within the organisation being impacted by the use of a specific system, in this case a BI system (Opitz and others, 2012).

The Technology Acceptance Model (TAM) is a widely accepted *de facto* method to access the acceptance of information systems in organisations (King and He, 2006; Yousafzai and others, 2007). TAM has been both praised and criticised for its frugal nature and simplicity (Chuttur, 2009). These propose that the use of the system, which in turn, corresponds with the user acceptance is based on user-motivation predictions, which are influenced by the perceived usefulness and the perceived ease of use.

Perceived usefulness is the degree to which an individual trusts that a particular system will enhance their job performance (Davis, 1989); while perceived ease-of-use is the degree to which an individual trusts that a particular system will be effortless to use. The two individual beliefs mediate the influence on user acceptance, stemming, as they do, from other external variables (Zhang and others, 2008). While TAM is known to be economical on resources and finances; and it is also considered irrational that a simple model could be applied to an array of decisions and social behavioural outcomes across a wide range of technologies (Bagozzi, 2007).

TAM is seen as quite a general model, with true value being added by developing into specialisations. Examples of specialisation can be seen in the Modified TAM (Cheng-Hsin, 2009), as well as the contextual specificity added by McFarland and Hamilton (2006) with the addition of contextual variables.

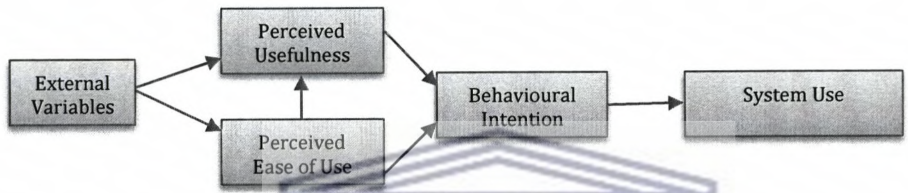


Figure 4.2 - Adapted BI Technology Acceptance Model (Davis and Venkatesh, 1996)

Acceptance of a BI system is no different from other TAM evaluations of system acceptance, where users are more and more becoming independent of their Technology Departments, and are seeking methods to become more self-sufficient in terms of querying information (Pettersson, 2012). This is characterised by self-service BI, where users are able to adapt queries to their specific informational needs; and they are increasingly able to customise the tool, according to these needs (Watson and Wixom, 2007).

However, this is not an easy task; since, according to Eckerson (2008), the number of active BI users in organizations is only approximately 24%; and therefore, a culture of information sharing and user acceptance of an intelligence system is key to its success. If the system is not used, it cannot become pervasive; and little value is gleaned from the BI investment.

The value derived from usage is characteristic of information systems, generally; and it is referred to as the "productivity paradox", which refers to the lack of any adequate return on technology investments, despite the implementation of state-of-the art systems due to lack of system usage (Venkatesh and Davis, 2000). Pettersson (2012:18) demonstrated that when using the TAM model in a BI scenario, it "did not show the same kind of explanatory power for either self-reported or actual usage, as did previous studies in other settings"; since the purpose of a BI system is to increase the efficiency of business decisions and activities.

This implies that the user is only interested in using the system for what is required, according to their informational need at the time; and therefore, the key factor is the usefulness of the system when required – and not the frequency of usage of the system (Pettersson, 2012). This means that in the case of BI systems, TAM cannot adequately explain the value; as many variables that are specific to a BI situation cannot be evaluated by using TAM; since the usage of the system is dependent on the role of the users and the tasks for which they are responsible.

4.4. Proposed conceptual model based on the literature

Based on the review of literature in Chapter 2 and Chapter 3, together with the frameworks and methods presented above, critical success factors could be identified by isolating those that have been thoroughly investigated in the literature and frameworks/methods reviewed that impact the value of an organisation's BI. These factors are: information quality (5.1); customer/consumer impact (5.2); the access to information (5.3); the human component made up of organisational culture and user capabilities (5.4); and the linkage between organisational-performance management and BI implementation (3.5.5).

The last factor is split into an internal process and an external environmental perspective.

4.4.1. Information Quality

The importance of Information Quality as a key factor has been highlighted most frequently in studies analysing the benefits of BI investments. A number of elements are used to gauge information quality. Pranjic and others (2011) (5.1.1) summarise the value of information quality by looking at the usefulness of information relative to the amount of information available. Watson and others (2002) stated that Information Quality can be seen as the most tangible of benefits with outcomes, such as improved processes, better decision-making, and increased market share – as a subset of improved information quality. Popovič and Jaklic (2010) also state that information can be valued, according to its usefulness to the receiver, in relation to a specific task or output.

The value of information lies in its completeness, relevance, accuracy, timeliness and accessibility, with the last applying to the technological support required. Therefore, the research propositions related to information quality can be identified as:

P1a: The completeness of information is positively related to the value of BI.

P1b: The accuracy of information is positively related to the value of the BI.

P1c: The relevance of information is positively related to the value of BI.

P1d: The timeliness of information is positively related to the value of BI.

P1e: The correct amount of information is positively related to the value of BI.

4.4.2. Customer/Consumer Impact

Another key aspect identified from the literature reviewed is the impact that BI investments have on the organisation's customers. Taylor and others (2005) highlight the impact that information can have on the Customer-Lifetime Value (Figure 3.8). Based on this information, the following research propositions are derived:

P2a: An increase in customer-response rates is positively related to the BI system's value.

P2b: An increase in up-sell and cross-sell abilities in the organisation rates is positively related to the BI system's value.

P2c: An increase in the retention rates of customers' rates is positively related to BI system's value.

4.4.3. Information Accessibility

A BI system, as defined by Olszak and Ziemba (2007), is a collection of tools, technologies and programmed products used to collate, integrate, analyse and report information. Yeoh and Koronios (2010) break down the critical success factors for the implementation of BI systems into three key dimensions, specifically: organisational, procedural, and technological (3.5.3). Therefore, based on the above definitions, the following research propositions can be derived:

P3a: An increase in organisational communication rates is positively related to BI systems' value

P3b: Sufficiently compressing information to minimise the amount of memory taken up is positively related to BI systems' value

P3c: Sufficiently presenting information, based on the context of the scenario, is positively related to BI systems' value

P3d: Sufficiently securing information, in order to prevent leakages to and/or changes by unauthorised parties is positively related to BI systems' value

P3e: Standardising information across the organisation is positively related to BI systems' value

P3f: Providing alerts to the users, when necessary, in the workflow process rates is positively related to BI systems' value

P3g: Maintaining the integrity of the information at all times is positively related to BI systems' value

P3h: Ensuring operations are based on clearly defined roles and responsibility rates is positively related to BI systems' value

P3i: Ensuring that operations are clearly documented rates is positively related to BI systems' value

All the above speak to the capabilities made possible by gaining access to a BI system.

4.4.4. Culture and capabilities

A key component of a successful BI system is the presence of an analytical decision-making culture in the organisation (Popovič and others 2012). Sharma (2003) supports this by stating that the anticipated benefits may not be realised when organisations neglect the usage factor of the system (3.5.4). Based on the supporting evidence, the research propositions can now be defined as:

P4a: Access to information stored on the BI system adds value by increasing the individual user's level of knowledge

P4b: Being interoperable across all departments is positively related to BI systems value

P4c: Supplying data, according to the needs of the users, is positively related to BI systems value

P4d: Delivering information at the desired frequency of the users, is positively related to BI systems' value

P4e: Only one reporting system used in the organisation is positively related to BI systems' value

P4f: Evaluating changes, together with the functional departments and/or project team, which includes business-user representation is positively related to BI systems' value

P4g: Being able to be adapted, according to user satisfaction, based on regular measurement is positively related to BI systems' value

All the above propositions are tied to the usage of the BI system in an effective manner, in order to add value to the organisation.

4.4.5. Performance Management

Performance Management looks at the linkage between BI and the assessment of both an organisation's internal processes and external environment. It focuses on the strategic drivers, as well as the requirements for planning in the business. The linkage occurs when BI reporting is used to gauge the performance of Key Performance Indicators (KPIs), such as the Market Share, Profitability, Competitor Analysis, and Market Opportunities, amongst others (Pranjic and others 2011). Based on this, the research propositions can be formulated as:

P5a: Allowing for the measurement of KPIs is positively related to BI systems' value

P5b: Using common data for all performance reporting is positively related to BI systems' value

By having the ability to report on performance (P5b), it is possible to assess organisational performance against KPIs – based on factual information.

P5c: Ensuring management methods are integrated across the business and systems' rates are positively related to BI systems' value

P5d: The value of time taken to populate and report from the BI system not superseding the system's value, is positively related to BI systems' value

4.4.6. Conceptual Diagram

Based on the propositions above, as derived from the literature review conducted in Chapters 2 and 3, it is now possible to develop a conceptual model made up of the propositions. A conceptual model allows for the grouping of the propositions into a single model that represents the value of BI systems. Once a conceptual model has been developed, it is then possible to test that model for validity.

The diagram below represents the proposed Conceptual Model, based on the literature review conducted.

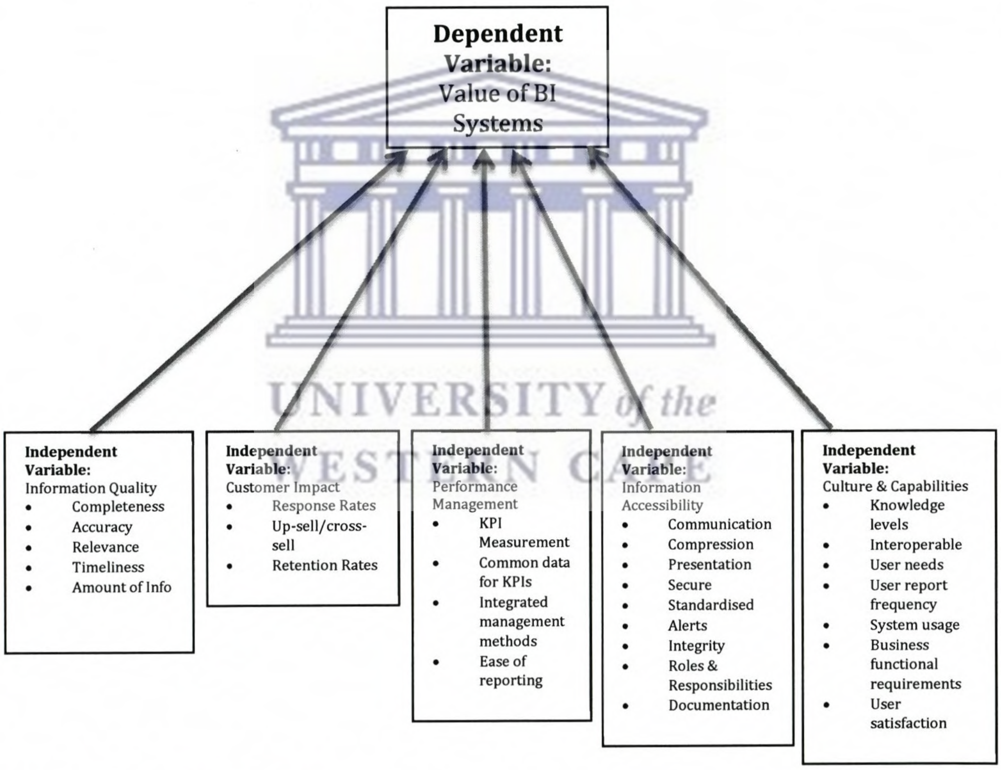


Figure 4.3 - Proposed Conceptual Design

The above figure represents the proposed conceptual design that will be tested by using the quantitative information gathered *via* the survey conducted. Each independent variable identified represents a factor that is estimated to have an impact on the dependent variable 'Value-of-BI'. Each independent variable is broken down into the sub-factors that define that independent variable. Each proposition in the above model can be mathematically represented as follows:

Table 4.2 - Research Proposition Equations

Research Proposition	Equation
P1a: The completeness of information is positively related to the value of BI systems	$Yval = \beta_0+\beta_1 compl+\varepsilon$
P1b: The accuracy of information is positively related to the value of BI systems	$Yval = \beta_0+\beta_1 acc+\varepsilon$
P1c: The relevance of information is positively related to the value of BI systems	$Yval = \beta_0+\beta_1 rel+\varepsilon$
P1d: The timeliness of information is positively related to the value of BI systems	$Yval = \beta_0+\beta_1 tim+\varepsilon$
P1e: The correct amount of information is positively related to the value of BI systems	$Yval = \beta_0+\beta_1 amt+\varepsilon$
P2a: An increase in customer response rates is positively related to BI systems; value	$Yval = \beta_0+\beta_1 resp+\varepsilon$
P2b: An increase in up-sell and cross-sell abilities in the organisation rates is positively related to BI systems' value	$Yval = \beta_0+\beta_1 sell+\varepsilon$
P2c: An increase in the retention rates of customers' rates is positively related to BI systems' value	$Yval = \beta_0+\beta_1 ret+\varepsilon$
P3a: An increase in organisational communication rates is positively related to BI systems' value	$Yval = \beta_0+\beta_1 comm+\varepsilon$
P3b: Sufficiently compressing information to minimise the amount of memory taken up is positively related to BI systems' value	$Yval = \beta_0+\beta_1 compr+\varepsilon$
P3c: Sufficiently presenting information, based on the context of the scenario is positively related to BI systems' value	$Yval = \beta_0+\beta_1 pres+\varepsilon$
P3d: Sufficiently securing information, in order to prevent leakages to and/or changes by unauthorised	$Yval = \beta_0+\beta_1 sec+\varepsilon$

parties is positively related to BI systems' value	
P3e: Standardising information across the organisation is positively related to BI systems' value	Yval = $\beta_0+\beta_1 std+\varepsilon$
P3f: Providing alerts to the users when necessary in the workflow process rates is positively related to BI systems value	Yval = $\beta_0+\beta_1 alert+\varepsilon$
P3g: Maintaining integrity of the information at all times is positively related to BI systems' value	Yval = $\beta_0+\beta_1 integ+\varepsilon$
P3h: Ensuring operations are based on clearly defined roles and responsibility rates is positively related to BI systems' value	Yval = $\beta 0+\beta_1 rol+\varepsilon$
P3i: Ensuring that operations are clearly documented rates is positively related to BI systems' value	Yval = $\beta_0+\beta_1 doc+\varepsilon$
P4a: Access to information stored on the BI system adds value by increasing the individual user's level of knowledge.	Yval = $\beta_0+\beta_1 know+\varepsilon$
P4b: Being interoperable across all departments is positively related to BI systems' value	Yval = $\beta_0+\beta_1 intop+\varepsilon$
P4c: Supplying data, according to the needs of the users, is positively related to BI systems' value	Yval = $\beta_0+\beta_1 need+\varepsilon$
P4d: Delivering information at the desired frequency of the users is positively related to BI systems' value	Yval = $\beta_0+\beta_1 freq+\varepsilon$
P4e: Only one reporting system used in the organisation is positively related to BI systems' value	Yval = $\beta_0+\beta_1 sys+\varepsilon$
P4f: Evaluating changes, together with the functional departments and/or project team, which includes business-user representation is positively related to BI systems' value	Yval = $\beta_0+\beta_1 func+\varepsilon$
P4g: Being able to be adapted, according to user-satisfaction, based on regular measurement, is positively related to BI systems' value	Yval = $\beta_0+\beta_1 satis+\varepsilon$
P5a: : Allowing for the measurement of KPIs is	Yval =

positively related to BI systems' value	$\beta_0+\beta_1 kpis+\varepsilon$
P5b: Using common data for all performance reporting is positively related to BI systems' value	Yval = $\beta_0+\beta_1 common+\varepsilon$
P5c: Ensuring management methods are integrated across the business and systems rates are positively related to BI systems' value	Yval = $\beta_0+\beta_1 mang+\varepsilon$
P5d: The value of time taken to populate and report from the BI system, not superseding the system's value, is positively related to BI systems' value	Yval = $\beta_0+\beta_1 diff+\varepsilon$

Each Research Proposition is represented by the mathematical equation $Y_{(value)} = \beta_0+\beta_{1(Variable)}+\varepsilon$, where:

Y represents the value of BI

β_0 represents the intercept variable, which represents the value if $\beta_{1(Variable)}$ is zero

$\beta_{1(Variable)}$ is that specific variable impacting the value of BI

ε represents the error value.

Table 4.3 below shows the definitions of all variables identified.

Table 4.3 - Variable Definitions

Variable	**Definition**
Compl	Completeness
Acc	Accuracy
Rel	Relevance
Tim	Timeliness
Amt	Amount of information
Resp	Response rates
Sell	Up-sell/cross-sell
Ret	Retention rates
Comm	Organisational communication

Pres	Presentation
Sec	Security
Std	Standardised
Alert	Alerts
Integ	Integrity
Rol	Roles and responsibilities
Doc	Documentation
Know	User knowledge
Intop	Interoperability
Need	User needs
Freq	Desired user frequency
Sys	Reporting system
Func	Functional requirements business representation
Satis	User satisfaction
Kpis	KPIs
Common	Common data
Mang	Management methods
Diff	Difficulty populating and reporting

The variables listed above make up the factors identified; and they can be statistically tested by using each proposition.

4.5. Conclusion

This chapter has identified and assessed the frameworks, methods and models that have previously been created and documented in the literature reviewed. Propositions associated with each factor identified in the literature are then specified together with the mathematical representation of each proposition. Thereafter, a conceptual model was developed detailing each factor identified in Chapter 3. The next chapter explores the Research Methodology used in this study.

5. Research Design

This chapter specifies the terminology, as well as the selected methodology and the research design, used in this study. The link is then given between the survey instrument used and the identified factors from the literature review. The chapter concludes by specifying the statistical analyses conducted on the collected data.

5.1. Research terminology and contextual definitions

The following are the most relevant research terms and definitions used in this study:

Research paradigm: Brunner (2006) defines a paradigm as a collectively accepted explanation or justification of scientific processes and claims; while Burrell and Morgan (2003) suggest that paradigms are "fundamentally different assumptions concerning the nature of the social science and the nature of society; that is, the 'commonality of perspectives, which binds the work of a group of theorists together'". Likewise, a number of definitions for the research paradigm also exist, such as that of Entman (1993) stating it: "As a general theory that informs most scholarship on the operation and outcomes of any particular system of thought and action"; while Chen (2005) sees it as, a "dynamic system of scientific works, including their perceived values by peer scientists, and governed by intrinsic intellectual values, and associated citation endurance and decay"; and Ponterotto (2005) explains it as the location of inquiry bound by the parameters of the philosophy of science, ontology, epistemology, axiology, rhetorical structure and methodology.

Ontology: Ontology deals with the nature of reality and being Ponterotto (2005); and it is a "formal and explicit specification of a shared concept that forms the basis for communications" Gruber (1993) – where the facts being communicated reside (Bergeron, 2003). Areas, such as communication, inference, knowledge-reuse and organisation have been identified as part of ontology, as well as the structuring and organisation of information, in order to convert it into knowledge (Daneshgar, 2004). This research investigates ways of evaluating this information and the structures that support it, as well as building and testing a conceptual model that can be used as a benchmark test.

Epistemology: Williams (2000) defines epistemology as, "how we know what we know and our authority for claims to knowledge". It deals with the "assumption, foundations, and nature of knowledge, as well as its extent and validity" relative to the society making use of that knowledge. Krauss (2005) stated that by doing so, the following questions can be addressed: What is knowledge? What relationship exists between the inquirer and the known? Where is what we claim to know derived from? What are the building blocks of knowledge? What evidence is there to convince us that something is "true"?

Epistemological foundations frame the research design. Within this study, a positivist approach is taken; since the results are based on the findings derived by quantitative research, and conducted according to scientific criteria.

Axiology: According to DeLuca and Kock (2007), axiology is the study of value and value judgements. Value in research is equated to "utility" or "desirability" Sánchez Fernández and Iniesta-Bonillo (2007) in relation to commodities and the consumers' perception of them. This thesis is focused on assessing the value attached to information and its supporting structures from an organisational perspective, and its impact on the business itself.

Rhetorical Structure: Garsten (2006) defines rhetoric as the art of persuasion or the techniques of presentation to estimate differing assumptions about the world and persuasions of its conclusions. Rhetorical structures refers to the communication constructs and knowledge presentation used to persuade the reader. As this study is predominantly quantitative in nature, the rhetoric must be as detailed as possible, while consistently remaining factually based, in order for the reader to fully comprehend the situation.

Methodology: Methodology is made up of the principles, processes and procedures of a scientific inquiry (Ponterotto, 2005). The method choice is specific to the ontology, epistemology, axiology and the rhetorical structures existing in the situation that the researcher is addressing.

Research methodology: If the above aspects of the philosophy of science are combined, and the most suitable of each is chosen, dependent on the research being conducted, this forms the overall Research Methodology. Due to the vast differences in the research field, a number of paradigms underpinning research have surfaced. Burrell and Morgan (2003) identify four research paradigms: Functionalism, interpretivism, radical structuralism, and radical humanism. Creswell and Plano Clark (2007) further define a quantitative paradigm, a qualitative paradigm, and the mixed-methods or multi-method paradigm. Other epistemological classifications include: The positivist, the interpretive, the critical social theory, constructivism and social constructivism (Klein and Myers, 1999).

5.2. Research methodology used in this study

The research presented in this study is based on that of the BI portion of the survey conducted by the value of BI project specified below. The survey itself is made up of predominately Likert-scale quantitative questions that gauge the presence of and investment in BI within a company. Questions around the perceived value of BI investments, as well as the envisaged issues of BI in the organisation, are presented as open-ended questions.

This study makes use of a combination of an exploratory and quantitative approach, in order to adequately assess whether the critical factors for BI systems' success are present in South African and German organisations.

The study began with a thorough analysis of existing literature, in order to identify the key factors that impact the value of BI systems. This also allowed for the formation of research propositions, based on solid research and testing. This is customary in exploratory designs; since their value in usage is to "identify the cause-effects relations and [to] explain the how and why phenomena occur" (Arnold, 2006). According to Creswell and Plano Clark (2007) exploratory designs are most valuable when there are no measures, instruments, known variables or guiding frameworks/theories available.

The literature review in Chapters 2, 3 and 4 included the most relevant identified studies, as well as supporting material, in order to frame the concept of BI systems and their role in South African and German organisations, together with the value they add. The key factors identified in previous studies allowed for the development of a proposed conceptual model that could be used to evaluate the responses received in the quantitative study.

5.3. Research Procedure

The overall goal of this study is to identify, describe and explain the critical factors that impact the value derived by organisations from BI systems. This entails identifying key factors from current literature, the construction of a conceptual model and the testing of quantitative survey results against a model, in order to identify any gaps, and to propose possible solutions.

Once the key critical factors for assessing the value of BI systems were identified from the literature reviewed and propositions identified, questions could then be specified, which could then be used to assess the validity of each proposition. In this way, each question appearing in the survey can be directly correlated with a specific aspect related to a factor that was identified in the literature review. Ensuring the alignment between the survey questions and the propositions derived from the literature review allows for the testing of the propositions statistically – by using responses gleaned from the survey instrument.

5.4. The larger project

The Impact of BI on a Corporate Performance-Management project, conducted by Hochschule Neu-Ulm University of Applied Sciences in conjunction with the University of the Western Cape, considers BI as a set of technologies and infrastructure to provide real-time data or information for decision-making. It is typically associated with Data Warehousing (DW), Online Analytical Processing (OLAP), Extraction, Transformation and the Loading (ETL) of data. BI systems enable the collation of a wide range of data from different systems and components, and the loading of these data in an integrated database ("single version of truth").

End-Users can then extract the integrated data from the database and use them for analysis and evaluation, in accordance with their informational needs ("Self-service BI").

However, there is currently a substantial deficit in both theory and practice to evaluate the value of BI systems. The analysis of the impact of BI systems on the organisation is seen as very complex. Evidence of BI systems value-addition, based on recognised benefits, is difficult to demonstrate; as there is often little concrete or practical alignment of BI systems with management activities. It is for this very reason that, according to some research studies, it is not easy to verify the positive impact of BI systems in business processes.

Due to the above reasons, the joint research project endeavoured to assess the impact of BI systems on corporate performance. The aim of the larger study was to analyze whether, and how far, BI systems could enhance the success of organizations in terms of planning, monitoring and the control of strategic and operational business activities.

This study is focused purely on the value of the BI systems' component of the larger project. While the larger project delves deeply into the link between corporate performance management and BI, this study has identified corporate performance management as one of five key factors that need to be investigated, in order to assess the value-addition of BI systems. The data gathered by the larger project is focused on the German corporate environment. This study uses the BI system's data component of the German data, together with the South African BI system's data that have been gathered.

5.5. Survey Design

The online survey, based on the literature, was designed over a period of two years with consultation across academia, as well as with large and medium-sized corporates. During the initial Project Workshop, conducted in July 2010, Value Measurement was presented as the largest issue, with BI identified in an empirical study in Germany (Technical University Chemnitz, 2010). From this initial workshop, the survey design took shape – using the input from ten corporate organisations and two universities.

The online survey is split into two areas, specifically a corporate performance-management (business-centric) section and a BI (IT-centric) section, where the respondents could choose which section they wish to represent.

The first part of the part of the survey deals with the general organisational descriptive questions, such as company turnover, company performance, number of employees, length of operation, industry, and the company's operational, reporting and technological design. Once the descriptive aspect was covered, the questionnaire moved into either corporate-performance management or BI-specific questions.

Key questions were presented with a seven-point Likert Scale answer rating ranging from "Totally Disagree" to "Totally agree", and included "Statement not relevant" and "I do not know" options. In this way, the answers received leaves flexibility for the researcher to decide on a statistical analytical approach, which could include Correlation analysis, Factor analysis, Discriminant analysis, or Structural-equation modelling, dependent on the research requirement. Open questions were finally asked at the end of each survey – on the largest value items and any foreseeable future issues for the respondent associated with corporate-performance management and BI.

Table 4.4 below shows the correlation between the literature and theme areas within the survey, in which the specific questions were developed.

Table 5.1 - Factor link to Questionnaire

Information Quality	**Chapter Reference**
Data used in our business processes is: -Consistent; -Complete; -Relevant; -Current	3.2.3.1
In our organisation, BI provides a sufficient feature set for: -data analysis; -forecasting; -statistical analysis; -sharing/disseminating data; -presenting data; -mobility; -adding comments	3.2.3.1
In our organisation, management methods and business processes run smoothly without data disruption.	3.2.3.1
Information Accessibility	
Our BI system cannot be arbitrarily changed by users, since users have to follow specific standard procedures for system changes.	3.2.3.2
In our organisation, the procedures for system changes are standardized across all functional levels.	3.2.3.2
In our organisation, the meta-models in all BI databases are standardized (even if there are a variety of database formats).	3.2.3.2
In our organisation, data changes of BI-relevant master data (e.g. hierarchies) can be traced.	3.2.3.2
In our organisation, versioning control of BI-relevant master data (e.g. hierarchies) are practised.	

In our organisation, BI provides a sufficient feature set for alerts linked to the automated workflow data in our operational business processes.	3.2.3.2
In our organisation, users have simultaneous access to data, while maintaining data integrity.	3.2.3.2
In our organisation, the BI-Architecture, which defines the existing BI components, is binding throughout the whole enterprise.	3.2.3.2
In our organisation, the operation of the BI system is based on clearly defined roles and responsibilities.	3.2.3.2
In our organisation, the enhancement of the BI system is based on clearly defined roles and responsibilities between our functional and IT departments.	3.2.3.2
In our organisation, we consider regulatory requirements by operating our BI system (if available), e.g. legal obligations to keep the data.	3.2.3.2
In our organisation, the operation of the BI system is in compliance with clearly defined user rights.	3.2.3.2
In our organisation, the BI architecture is described in an appropriately detailed document.	3.2.3.2
Customer Focus	
In our organisation, our users use the feature set for: -data analysis; -forecasting; -statistical analysis; -sharing/disseminating data; -presenting data; -mobility; -adding comments.	3.2.3.3
Culture and Capabilities	
In our organisation, the meta-models use the same standardized terminology.	3.2.3.4

In our organisation, the BI-Tools used for corporate performance-management processes are interoperable.	3.2.3.4
In our organisation, the BI-tools used for corporate performance-management processes are the same for each functional area.	3.2.3.4
In our organisation, BI components supply data, according to the needs of the users.	3.2.3.4
In our organisation, the frequency of data supply is determined by the user (e.g. real-time, daily, weekly).	3.2.3.4
In our organisation, users use only the implemented BI-solutions.	3.2.3.4
In our organisation, all new requirements of BI are documented and evaluated by functional departments or a project team.	3.2.3.4
In our organisation, we take action to increase user-BI satisfaction, based on regular measurement.	3.2.3.4
Performance Management	
Our company uses measurable indicators (Key Performance Indicators and metrics), based on Business Strategy (e.g. vision, mission, objectives).	3.2.3.5
All our corporate performance-management processes use common data.	3.2.3.5
Our management methods (e.g. Balanced Scorecard, performance pyramid) are integrated throughout all our corporate performance-management processes (e.g. Integration of Balanced Scorecard with the Management by objectives process).	3.2.3.5

The effort needed to populate our corporate performance-management system with data is less than the value of the output used for strategic decisions (optimized input-output-ratio).	3.2.3.5
Please evaluate the attributes that are suitable to generate todays' greatest business value of BI in your organisation.	3.2.3.5

5.6. Sample

The study targeted organisations in both the public and private sectors operating in South Africa and in Germany. The study was split into two components, one that focused on the business side of the organisation; and the other on the IT sphere, specifically the BI area. So, while the survey itself was pertinent to both sides, for the purposes of this study, the focus was on the BI component, with only questions pertaining to the reporting of corporate performance and overall organisational specifics applicable from the other component.

The target population for the BI component were specifically senior IT managers, Chief Information Officers or BI Managers via an online survey. Selected samples were drawn from the lists made available by companies listed on the South African stock exchange, German business groups, as well as emails sent out to a number of organisations chosen – based on their industrial standing, as well as their investment in BI.

Before starting the survey in Germany and South Africa, a pre-test was conducted with three companies. The survey further improved the clarity of the questions, and revised the survey design in terms of improved usability. Table 5.2 below shows the selection criteria confirmed after the pre-test.

Table 5.2 - Selection criteria for the empirical study in Germany and South Africa

Selection criteria for the empirical study in Germany and South Africa		
	Germany	**South Africa**
Target group	Management and IT management	Management and IT management
Industries	• Mining and quarrying and earth • Manufacturing • Energy supply • Construction	• Mining and quarrying and earth • Manufacturing • Energy supply • Construction • Financial Services
Turnover	> 50 million € / year	> 500 million ZAR / year

The criteria pre-test specified differences in the industries in each country, with Financial Services added in South Africa; as this was identified as a major industry in the country that required its own group. It was also agreed that the focus of the survey would be those companies with a turnover of more than 50 million Euros per annum in Germany, and 500 Rand per annum in South Africa.

In Germany, a total of 3324 contacts were gathered from the Hoppenstedt listing. Of this, a total of 2024 were found to meet the criteria specified, and were contacted. A total of 907 declined to participate, leaving a final sample of 1117. As many as 239 experienced issues with the survey, and did not complete; while 404 opened the survey but did not complete. A total of 849 reminders were initiated: either telephonically, or via email. Finally, 165 surveys were completed, 75 of which were the BI component.

A total of 3661 contacts were extracted from the MailChimp South African CEO and CIO database. A total of 513 were unreachable. Approximately 800 follow-ups were done via email and telephone calls. A total of 69 responses were gathered, 38 of which were the BI component. Therefore, a total group of approximately 1500 contacts were queried, with 234 responses received. A final number of 113 responses were specific to BI. This equates to a confidence interval of 5.9 at a confidence level of 95%, which, while being a low response rate, is acceptable for this study (Krejcie and Morgan, 1970).

A low response rate can lead to sampling bias if the non-response is unequal among the participants' exposure and/or outcome. While many researchers link a higher response rate with more accurate survey results (Aday, 1996; Babbie, 1990; Backstrom and Hursh, 1963; Rea and Parker, 1997), newer studies showed that surveys with lower response rates (near 20%) yielded more accurate measurements than did surveys with higher response rates (near 60 or 70%). (Visser, Krosnick, Marquette and Curtin, 1996).

5.7. Data Collection Method

Fink (2005) highlighted the fact that the choice of data collection method is based on considerations of practicality and quality, based on the type of data being collected. The data-collection method used in this study is a web-based online survey. This allows for the gathering of information from a representative sample, in order to be able to generalise these findings to a population, with the limits of a random error being taken into account (Bartlett and others 2001).

Online surveys are advantageous; since they allow for the elimination of a number of costly resources, including paper, postage and data entry, as well as reducing the time required for implementation; while making it easier to send out reminders to respondents, to conduct follow-ups and import data into programmes used for the data analysis (Dillman, 2000). Online surveys also allow for better speed of data collection, convenience for both the respondent and the researcher, anonymity, and a larger sample reach (Grandcolas and others, 2003; Couper and others, 2001; Epstein and others, 2001).

However, like other forms of surveying, according to Basi (1999) a smaller number of recipients should be expected from online surveying; since a number of contributing factors need to be taken into account, including time constraints, dislike of completing surveys and lack of sufficient incentives. It is also difficult to assess the non-response in online surveying; as responses are kept anonymous, and invitations were done via mailing lists. As in any large study, bias is a risk for the analysis results. In the case of this study, bias could have been introduced with the exclusion of those organisations without online access; and which were, therefore, not able to complete the survey. This was circumvented by limiting the sample to medium and large organisations only.

It is imperative during online surveying to maintain confidentiality and privacy, as well as anonymity (Kraut and others, 2004). In order to do this, the following steps were taken to ensure that these were in place:

- Anonymity was ensured throughout the survey, with the only personal field being an optional email address field for those wishing to receive feedback on the survey results.
- Email addresses were kept confidential at all times.
- All systems used were kept secure; and any identifying data were stored securely, and destroyed once used.
- All final statistical results were presented, so that no individual responses could be isolated.

5.8. Methods of Data Analysis

Questions appearing in the survey developed were collected into groups that could be used to assess a specific focus area. Once this was done, correlations were then drawn for each question, and grouped into dimensions in which assessment of answers was to occur. For BI, these dimensions were identified as Technical Integration, Functional Scope, Technical Information Quality, Governance and Operations, Consistency of Data Models, Automation of processes, Process-Management functionalities, Logical-Data Aggregation, Traceability to original source, Data consistency, Consistency of Tools, Data completeness and integrity, Data timeliness, Technical Documentation / Conventions, Clear and Transparent establishment of responsibilities, Binding IT architecture, Consistency of Tools, Analytical Functionality, Presentation/Delivery, Comments and Extensions and Compliance and User rights/Legitimacy.

In order to best analyse the data received from the online survey, a number of statistical and data-analytical methods were used. Firstly, all descriptive statistics were used to analyse the make-up of the sample, and the nuances of the different categories of respondents. Thereafter, a Factor Analysis was conducted, in order to test all the propositions made and their impact on the independent variable of 'Value of BI'. Finally, structural-equation modelling by means of partial least squares was used to test the overall research question.

Statistical analysis of the data was performed using the Tableau for all Descriptive Statistics, SPSS for Frequency, Skewness and Kurtosis Analysis, as well as Factor Analysis and SmartPLS for Structural-Equation Modelling – Partial Least-Squares analysis. Descriptive statistics explain the main characteristics of the data in the sample. Frequency represents the number of times a score occurs. The frequency that is distributed normally is represented by a bell curve. Deviations from normal distribution occur when there is a lack of symmetry, which is referred to as skewness, or a lack of pointedness called kurtosis.

Skewness can be either positive or negative; and it shows the clustering of responses; while kurtosis shows the clustering of responses at the ends of the distribution (Field, 2013).

5.9. Factor Analysis

In order to assess the link between BI and each factor identified, a Factor Analysis, as specified by Field (2013) would need to be done – by specifying and then analysing the model, and thereafter, evaluating the model fit. The factors identified are discussed in detail, in order to generate research propositions (abbreviated as Ps), in order to empirically test each factor.

Factor analysis is a statistical method that allows for the reduction of the dataset to a smaller set of factors, each of which can be described in terms of a number of variables. The relative importance of each variable to its factor can also be specified. This method can, therefore, be used to find the core factor(s) that impact the dependent variable (Field, 2013).

This method of analysis aims to explain the maximum amount of common variance and/or the total variance in a correlation matrix – by using the least amount of factors, or latent variables, as explanatory constructs, which cluster variables that correlate highly into groups (Field, 2013). This explanation entails reducing the factors to the minimum amount of variables that would explain changes in the factor in question. Once a cut-off point is decided upon, correlation between the specific questions and the identified factor can be specified.

5.10. Structural Equation Modelling

Partial Least Square – Structural-Equation Modelling (PLS-SEM) is a modelling approach based on causality that attempts to maximise the explained variance of dependent latent constructs; and it is a method that has become more and more established in business research (Hair and others, 2013).

Structural-equation modelling differs from multiple-regression techniques in that it is based on causal relationships, in which the basic assumption is that a change in one variable results in a change in another variable (Hair and others, 2013).

SEM consists of two sets of equations, namely, the structural equation that represents the significance of paths between unobservable latent variables and the measurement equation that demonstrates the relationships between the indicator variables and the latent variables that they measure (Igbaria and others, 1997).

The diagram below represents a basic path model.

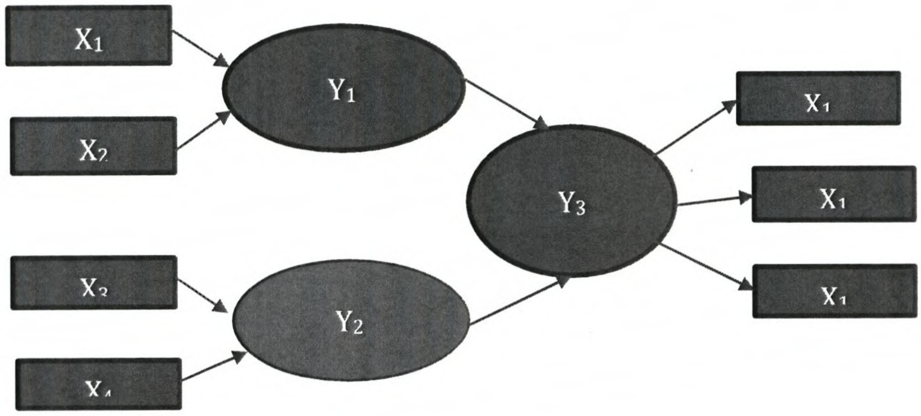


Figure 5.0.1 - Basic Path Model

According to Hair and others (2013), the building of the above model is done in two stages: first an iterative estimation of latent construct scores, which entails an outer approximation of latent construct scores (Y_1, Y_2 and Y_3), the estimation of proxies for structural-model relationships between latent constructs (P_1 and P_2), an inner approximation of latent construct scores, and finally, an estimation of proxies for coefficients in the measurement models (W_1 to W_7).

Thereafter, the next stage is to determine the final estimates of coefficients by using the ordinary least-squares method for each partial regression in the PLS SEM model (Hair and others, 2013).

For this study, the coefficients identified were directly correlated back to the factors identified in the factor analysis, as well as the factors identified in the literature review. Similar to the Factor-Analysis method, the questions identified in the survey are correlated with the factors identified. The coefficient estimates then give the relationships between the variables making up each factor, as well as between factors.

The value of using the PLS-SEM lies in the fact that it is able to assess the relationships between the factors identified in the factor analysis and the direction and strength of these relationships.

5.11. Conclusion

This chapter summarises the key theories and terminologies that are associated with this study. A background of the research project completed was given, followed by an explanation of the online survey, on which the quantitative section of this thesis is based.

A link is then drawn between the theoretical factors identified in Chapters 2 and 3; and the online survey was then conducted. The research design was then explained, and the research instruments proposed. The next chapter delivers the results of the data analysis conducted on the information gathered from the quantitative study.

6. Data Analysis and Findings

Chapter 5 specified the methodology followed in this study. Building on the findings of the literature review presented in Chapters 2, 3 and 4, this chapter uses the data gathered during the survey as a base to test and quantify the critical factors impacting the value of BI systems, as identified in the literature.

In order to quantify the factors identified in the literature review, a draft conceptual model was created in Chapter 3; after which the propositions were formulated in Chapter 4. The conceptual model and the propositions based on the literature will be tested against the empirical data.

This chapter thus endeavours to confirm or reject the propositions stated – by first looking at descriptive statistics of the sample analysed, followed then by a factor analysis, and finally by conducting a partial least squares-structural equation modelling analysis (PLS-SEM).

6.1. Data preparation

The data preparation involved the collation of data derived from the online survey software Eval&GO (www.evalandgo.com) into Microsoft Excel 365 for data cleaning. Cleaning involved the removal of all incomplete and inconsistent data. As specified in Chapter 5, a total of 232 respondents completed the survey from South Africa and Germany combined, 113 of which were from a BI perspective. It was impossible to follow up on specific incomplete responses; since for reasons of anonymity, personal details were captured on the respondents. Incomplete responses were removed from the sample on a case-wise basis.

Once the clean-up of the data had been completed, the data were then loaded into Tableau 8.1 for descriptive statistical analysis. This included company information, technical information and BI-specific information. The data were also extracted with reference to each of the propositions. These data were then analysed in Microsoft Excel 365 – to develop graphs, and smartPLS 2.0 for partial least-squares analysis, as well as SPSS 22 for frequencies, skewness and factor analysis.

6.2. Descriptive statistics

6.2.1. Company-specific

Figure 6.1 below highlights the key descriptive statistics from an organisational perspective.

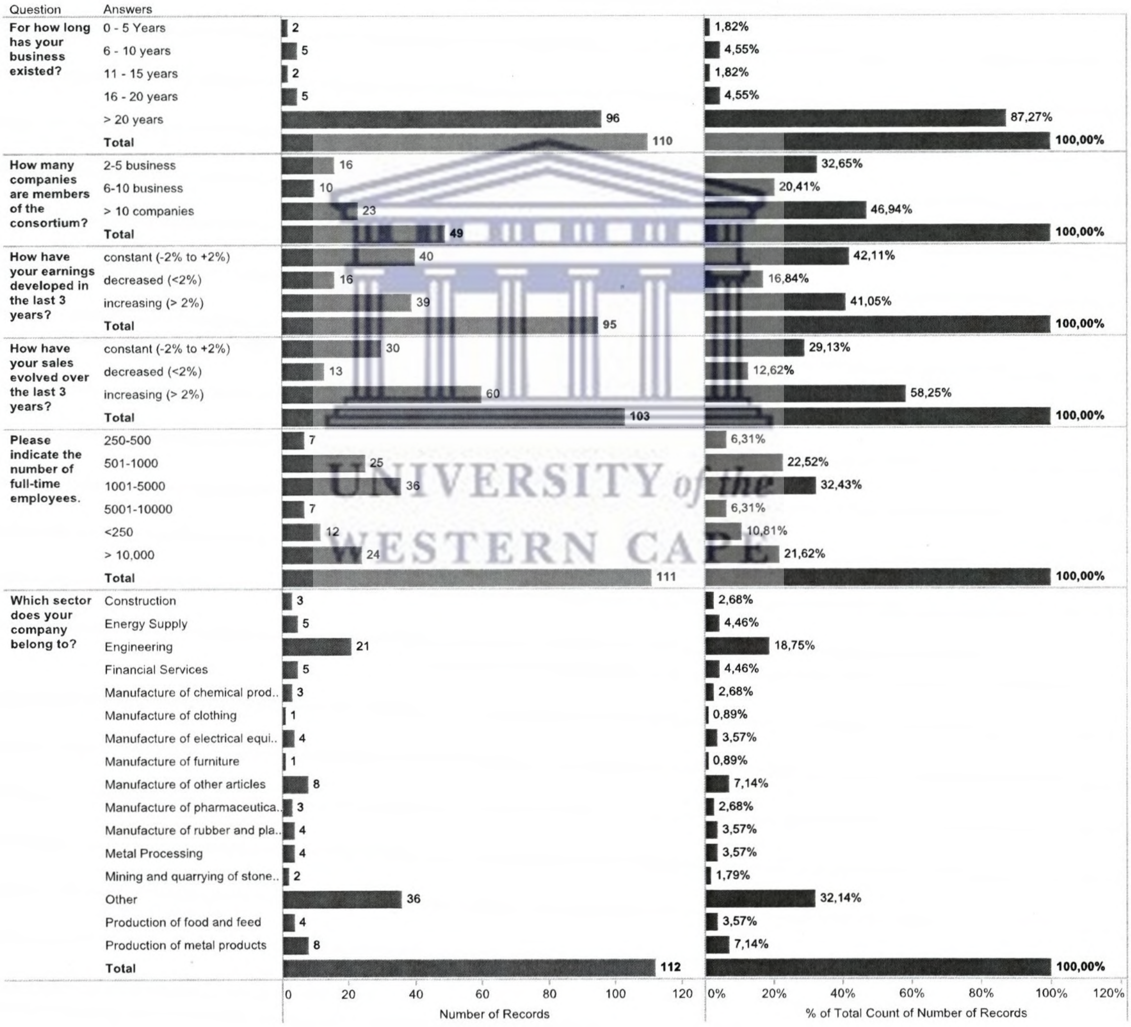


Figure 6.1 - Company-specific Statistics

Age of organisation: The results show that the majority of the respondents (87.27%) represent companies that have been in existence for more than 20 years, which was to be expected because of the focus on medium and large companies. It is vital that companies that have been trading for a long period of time, and are therefore seen as well-established, be assessed in terms of their BI value.

Number of companies in consortium: Only 49 respondents stated that they were part of a consortium. Being part of a wider consortium normally implies that IT architecture and software decisions are taken centrally, in order to minimise costs, and that the cost-effectiveness of IT investments, such as BI systems, are looked at in terms of the value that they can add to the company as a whole.

Earnings – last 3 years: A total of 41.05% of respondents have seen a positive growth in their earnings. The rest of the respondents indicated that their earnings had remained constant (42.11% of respondents), or decreased (16.84% of respondents) over the last three years. The earnings breakdown provides a solid basis for research into BI systems value-addition; since the respondents are able to look at the value that has been contributed to their organisation by BI systems.

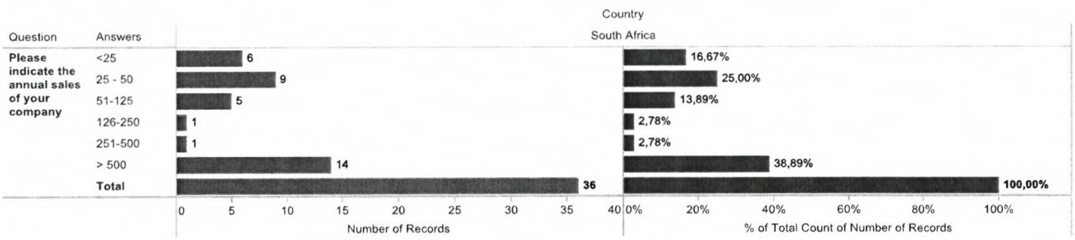
Sales – Last 3 years: In line with earnings, the majority of the respondents have seen a positive growth in sales – predominantly increasing (58.25% of respondents). A total of 29.13% of the respondents indicated that sales had remained constant; while only 12.62% of the respondents had experienced a decrease in their earnings over the last three years. The positive or negative sales over the last three years will, amongst others, be used to determine the value of BI.

Number of full-time employees: Of the 113 respondents who completed usable questionnaire results, 21.62% of these respondents were from companies employing in excess of 10 000 employees. As many as 10.81% specified that they represented companies with less than 250 employees; while 32.43% fell into the category of 1000 to 5000 employees. The employee numbers again highlight the fact that the respondents were mostly from larger companies employing in excess of 1000 employees.

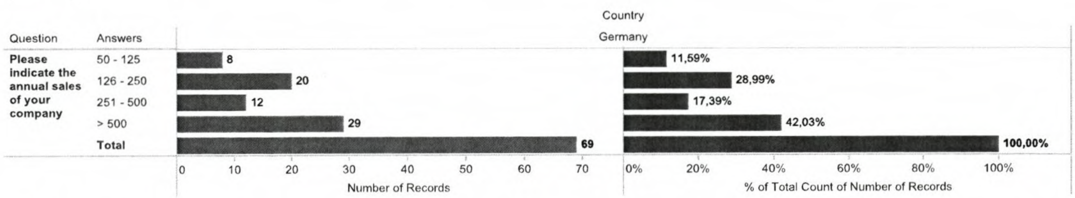
Company sector: The largest sector (32.14%) is listed as "Other", which shows that most of the respondents were not from the manufacturing, mining or construction sectors, but rather from retail or Fast-Moving Consumer Goods (FMCG) sector. In South Africa, the second highest sector is that of financial services, at 10.3%. This is in line with the sectorial distribution of business turnover in South Africa, in accordance with the Bureau of Economic Research report (Ligthelm, 2010), where a combination of trade, transport, storage and communication, community, social and personal service, fishing and forestry, electricity, water and gas, and real estate and business services, contribute the largest percentage of turnover.

Similarly in Germany, according to an article in Forbes Magazine on Global 500 Countries (2010), the services and engineering industries are the largest in the country, in line with the split seen in the demographic statistics. The sector analysis shows that the sample on which the value of BI systems investigation was undertaken is significantly representative of the population as a whole.

6.2.2. Annual Sales



(In ZAR)



(In Euro)

Figure 6.2 - Annual Sales

Annual sales: Most of the South African respondents (38.89%) have an annual turnover in excess of ZAR 500 million. This is in line with the sectorial distribution of business turnover in South Africa, and in accordance with the Bureau of Economic Research report (Ligthelm, 2010), where large businesses contribute 74.8% of the total turnover in the country. Likewise with the German respondents, 42.09% reported a turnover in excess of Euro 500 million.

6.2.3. Technology

The figure below highlights the key technology answers collected from the online survey.

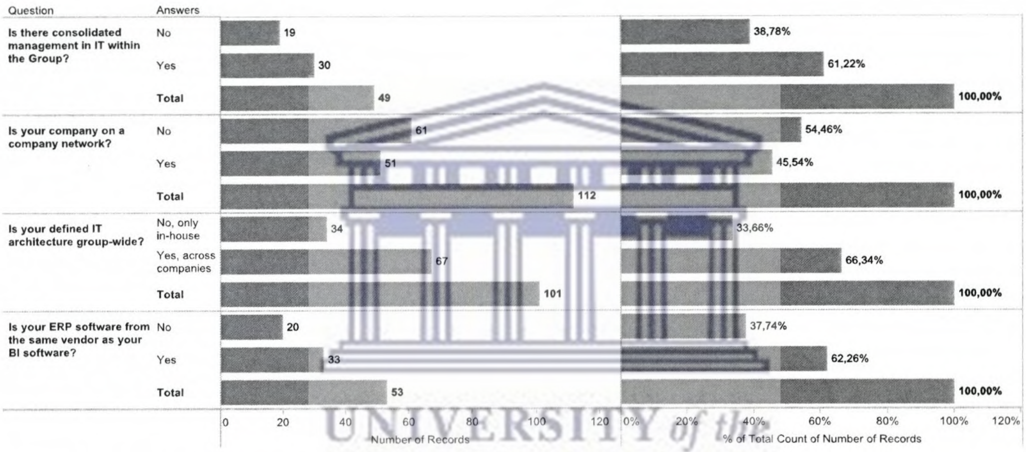


Figure 6.3 - Technology

Consolidated IT Management: Of the 49 respondents that answered the question related to consolidated IT management in their organisations, 61.22% were in agreement. This demonstrates that IT decision-making is centralised, including the selection of IT products and vendors. In this way, economies of scale can be used for IT decision-making, which is key in assessing the impact that BI systems have on value across a large organisation.

Company Network: The majority of the respondents (54.46%) did not have a company network in place. This indicates an existing problem in promoting the sharing of data and information effectively within the organisation. Based on the earlier statistics pointing to the majority of the sample being significantly large organisations, it is surprising to find that a larger contingent do not have a shared network platform. The lack of company-wide networks has wider implications; since it brings into question the culture of the sharing of data and information within those organisations, and hence the value that BI systems can add within these organisations, because the sharing of information is key to BI system-value addition (Chapter 3.2.3.4).

IT Architecture: A total of 66.34% of the respondents agreed that group-wide IT architecture is in place in their organisation. By having a group-wide IT architecture in place, IT systems are implemented and managed consistently across the organisation. This is a positive sign; as it implies that most organisations have the groundwork prepared to effectively implement a BI system that could possibly deliver benefits and value to the organisation. This also restricts the BI systems decision; since it is required to integrate with the existing IT architecture in the organisation.

ERP software: Of the 53 respondents that answered the question related to common ERP and BI manufacturer products usage in their organisations, 62.26% were in agreement. This clearly demonstrates a preference by organisations to work with a single product or platform for both their ERP and data-management needs. This finding is key to the selection of BI systems by organisations.

6.2.4. BI Expenditure

The table below represents a complete list of the respondents who indicated their current BI expenditure.

Table 6.1 - BI Expenditure

Which sector does your company belong to?	How has your earnings in the last 3 years developed?	Please indicate the number of your full-time employees.	For how many years has your business existed?	What was your organisation's total expenditure for BI in the last five years (in ZAR)?
Manufacture of other articles	constant (-2% to +2%)	1000-5000	> 20 years	200 000 000
Other	constant (-2% to +2%)	1000-5000	> 20 years	170 000 000
Manufacture of chemical products	increasing (> 2%)	> 10,000	> 20 years	100 000 000
Engineering	constant (-2% to +2%)	> 10,000	> 20 years	100 000 000
Manufacture of other articles	decreased (<2%)	> 10,000	> 20 years	80 000 000
Other	increasing (> 2%)	1000-5000	> 20 years	50 000 000
Mining and quarrying of stones and earth	decreased (<2%)	> 10,000	> 20 years	50 000 000
Financial Services	increasing (> 2%)	> 10,000	> 20 years	50 000 000
Energy Supply	decreased (<2%)	1000-5000	> 20 years	50 000 000
Engineering	constant (-2% to +2%)	> 10,000	> 20 years	50 000 000
Other	constant (-2% to +2%)	> 10,000	> 20 years	30 000 000
Other	constant (-2% to +2%)	> 10,000	> 20 years	25 000 000
Other	increasing (> 2%)	> 10,000	> 20 years	20 000 000
Production of metal products	increasing (> 2%)	1000-5000	> 20 years	17 000 000
Other	increasing (> 2%)	> 10,000	> 20 years	15 000 000
Other	increasing (> 2%)	> 10,000	> 20 years	10 000 000
Manufacture of electrical equipment	increasing (> 2%)	5000-10000	> 20 years	10 000 000
Energy Supply	increasing (> 2%)	1000-5000	> 20 years	10 000 000
Metal Processing	increasing (> 2%)	1000-5000	> 20 years	10 000 000

Manufacture of pharmaceutical products	constant (-2% to +2%)	500-1000	> 20 years	7 500 000
Other	constant (-2% to +2%)	> 10,000	> 20 years	7 000 000
Production of food and feed	constant (-2% to +2%)	> 10,000	> 20 years	6 000 000
Manufacture of chemical products	increasing (> 2%)	1000-5000	> 20 years	6 000 000
Manufacture of electrical equipment	decreased (<2%)	500-1000	> 20 years	6 000 000
Other	constant (-2% to +2%)	> 10,000	> 20 years	5 000 000
Other	increasing (> 2%)	1000-5000	> 20 years	4 000 000
Other	increasing (> 2%)	<250	> 20 years	4 000 000
Engineering	constant (-2% to +2%)	250-500	> 20 years	4 000 000
Other	constant (-2% to +2%)	500-1000	> 20 years	2 500 000
Other	constant (-2% to +2%)	1000-5000	> 20 years	2 000 000
Manufacture of furniture	increasing (> 2%)	1000-5000	> 20 years	1 500 000
Other	decreased (<2%)	250-500	> 20 years	1 000 000
Engineering	increasing (> 2%)	1000-5000	> 20 years	1 000 000
Production of food and feed	decreased (<2%)	500-1000	> 20 years	1 000 000
Production of metal products	decreased (<2%)	500-1000	> 20 years	1 000 000
Other	increasing (> 2%)	250-500	6 - 10 years	500 000
Other	constant (-2% to +2%)	<250	11 - 15 years	200 000
Energy Supply	constant (-2% to +2%)	500-1000	> 20 years	200 000
Engineering	constant (-2% to +2%)	500-1000	> 20 years	50 000

Of the 39 respondents that specified their spending on BI, the range of expenditure lies between ZAR 50 000 and ZAR 200 million, with an average of ZAR 28.4 million, and a median of ZAR 7.5 million. The highest spending's were seen in companies involved in unspecified articles and chemical manufacturing. This could be because of a large dependency on data in these organisations that justifies a large investment in BI systems. The majority of companies with the highest levels of spending are well established, and have been in existence for over 20 years.

The figure below shows the percentage split of expenditure in respondent organisations.

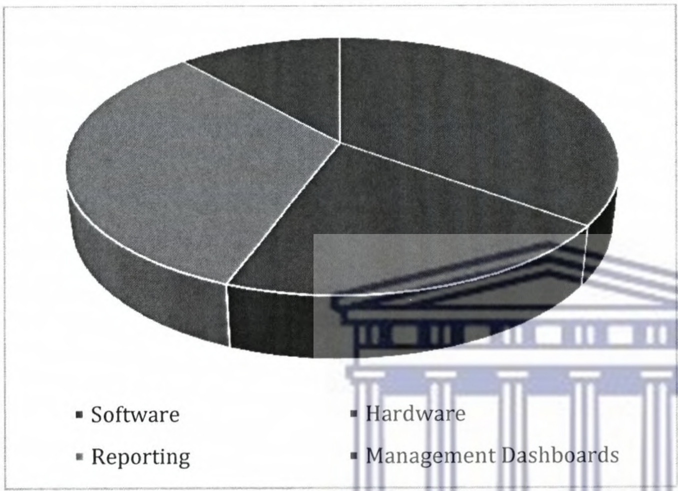


Figure 6.4 - BI Expenditure Split

On average, the largest spending in terms of BI, according to the results of the survey was on software (35.30%), followed closely by reporting (32.75%). This implies that while large initial outlays are spent on hardware (20.38%), the majority of BI spending is attributed to the management of the software, as well as report-building. The problem faced after the initial implementation cost is the ongoing maintenance of software and reporting, as well as the development of new and *ad hoc* reports and reporting.

This expenditure could be circumvented with newer BI product offerings, such as Qlikview and Tableau, where users can build their own reports and dashboards, and thereby limit the cost of reporting and management dashboards over time. This empowerment of the user, and the possible cost savings, could have a positive impact on the value addition of BI systems in organisations.

6.2.5. Software

Figure 6.3 below represents the usage of BI products, as specified by the respondents in the survey conducted.

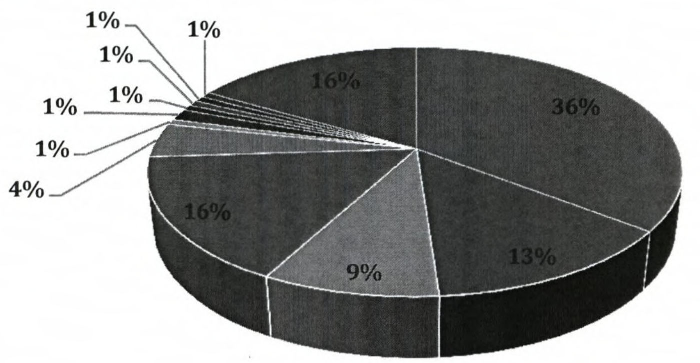


Figure 6.5 - BI Software

The most popular BI products, in which the respondents had invested comprised SAP (inclusive of the ERP system, as well as Business Objects and Crystal Reports – 36%) and IBM products, including Cognos (16%). This is followed by Microsoft products (inclusive of Microsoft Excel – 13%) and Oracle (9%).

The table below represents the BI products by the organisations, according to their size, earnings and industry type. By using the dimensions listed in the table, it is possible to identify which BI systems are most popular based on the make-up of the organisation in question.

Table 6.2 - BI Software by Organisation

Which sector does you company belong to?	How have your earnings in the last 3 years developed?	Please indicate the number of your full-time employees.	How many years has your business exist?	Which BI products do you use?
Construction	constant (-2% to +2%)	1000-5000	> 20 years	SAP

Construction	constant (-2% to +2%)	250-500	> 20 years	SAP; Crystal Reports
Energy Supply	constant (-2% to +2%)	1000-5000	> 20 years	SAP; Microsoft
Energy Supply	constant (-2% to +2%)	500-1000	> 20 years	SAP
Engineering	constant (-2% to +2%)	> 10,000	> 20 years	SAP
Engineering	constant (-2% to +2%)	> 10,000	> 20 years	SAP (BW, BO, SEM-BCS, Portal); (Oracle)
Engineering	constant (-2% to +2%)	250-500	> 20 years	SAP
Engineering	constant (-2% to +2%)	500-1000	> 20 years	SAP
Engineering	constant (-2% to +2%)	500-1000	> 20 years	IBM
Manufacture of electrical equipment	constant (-2% to +2%)	500-1000	> 20 years	SAP
Manufacture of other articles	constant (-2% to +2%)	1000-5000	> 20 years	SAP (ERP and Business Objects); Oracle (DW); Microsoft (SQL Server, Excel); Qlikview
Manufacture of other articles	constant (-2% to +2%)	1000-5000	> 20 years	SAMAC; Limesurvey
Manufacture of other articles	constant (-2% to +2%)	500-1000	> 20 years	MIK AG; Konstanz
Manufacture of pharmaceutical products	constant (-2% to +2%)	500-1000	> 20 years	SAP; IBM; Oracle
Manufacture of pharmaceutical products	constant (-2% to +2%)	500-1000	> 20 years	SAP
Manufacture of rubber	constant (-2% to	500-1000	> 20 years	Microsoft;

and plastic products	+2%)			Cubeware
Metal Processing	constant (-2% to +2%)	1000-5000	> 20 years	SAP
Other	constant (-2% to +2%)	> 10,000	> 20 years	ETL = DataStage (IBM); (SAP); SSIS (Microsoft) Db = MSSQL (Microsoft); Db2 (IBM); Business Objects (SAP); SSRS (Microsoft); SAS
Other	constant (-2% to +2%)	> 10,000	> 20 years	Data stage from IBM; Business Objects from SAP
Other	constant (-2% to +2%)	> 10,000	> 20 years	Microsoft Oracle
Other	constant (-2% to +2%)	1000-5000	> 20 years	Tableau; Qlikview; self-developed
Other	constant (-2% to +2%)	1000-5000	> 20 years	SAP; IBM; Oracle
Other	constant (-2% to +2%)	1000-5000	> 20 years	SAP
Other	constant (-2% to +2%)	500-1000	> 20 years	SAP
Production of food and feed	constant (-2% to +2%)	> 10,000	> 20 years	MicroStrategy
Production of metal products	constant (-2% to +2%)	> 10,000	> 20 years	SAP; Microsoft; Cognos
Energy Supply	decreased (<2%)	1000-5000	> 20 years	SAP
Engineering	decreased (<2%)	> 10,000	> 20 years	SAP; QlikTech
Engineering	decreased (<2%)	1000-5000	> 20 years	SAP

Engineering	decreased (<2%)	5000-10000	> 20 years	SAP; Microsoft
Engineering	decreased (<2%)	500-1000	> 20 years	SAP; IBM; Cubeware
Manufacture of electrical equipment	decreased (<2%)	500-1000	> 20 years	Aruba Informatik; IDL
Manufacture of other articles	decreased (<2%)	> 10,000	> 20 years	SAP; HFM
Metal Processing	decreased (<2%)	5000-10000	> 20 years	Infor; MIK; Qlikview; Business Objects
Mining and quarrying of stones and earth	decreased (<2%)	> 10,000	> 20 years	Microsoft; SAP
Other	decreased (<2%)	> 10,000	> 20 years	Oracle; Business Objects; Other
Other	decreased (<2%)	250-500	> 20 years	Sintrix
Production of food and feed	decreased (<2%)	500-1000	> 20 years	Infor; MicroStrategy
Production of metal products	decreased (<2%)	500-1000	> 20 years	SAP; Gedys-Intraware
Energy Supply	increasing (> 2%)	1000-5000	> 20 years	SAP; Tagetik; Oracle
Engineering	increasing (> 2%)	1000-5000	> 20 years	SAP
Engineering	increasing (> 2%)	1000-5000	> 20 years	Oracle; IBM; Infor
Engineering	increasing (> 2%)	1000-5000	> 20 years	SAP
Engineering	increasing (> 2%)	1000-5000	> 20 years	Microsoft
Engineering	increasing (> 2%)	1000-5000	> 20 years	Targetik; SAP; Microsoft Excel
Engineering	increasing (> 2%)	5000-10000	> 20 years	Microsoft, IBM
Engineering	increasing (> 2%)	500-1000	> 20 years	SAP; Cognos
Financial Services	increasing (> 2%)	> 10,000	> 20 years	Cognos

Financial Services	increasing (> 2%)	> 10,000	> 20 years	Qlikview; Business Objects; Cognos
Financial Services	increasing (> 2%)	1000-5000	> 20 years	IBM Oracle
Manufacture of chemical products	increasing (> 2%)	> 10,000	> 20 years	SAP; Cubeware
Manufacture of chemical products	increasing (> 2%)	> 10,000	> 20 years	Microsoft
Manufacture of chemical products	increasing (> 2%)	1000-5000	> 20 years	SAP
Manufacture of electrical equipment	increasing (> 2%)	5000-10000	> 20 years	IBM; Cognos; TM1; Arcplan
Manufacture of furniture	increasing (> 2%)	1000-5000	> 20 years	SAP
Manufacture of pharmaceutical products	increasing (> 2%)	> 10,000	> 20 years	SAP; Cognos
Metal Processing	increasing (> 2%)	1000-5000	> 20 years	SAP
Other	increasing (> 2%)	<250	> 20 years	Qlikview; Sylvon; IBM; Microsoft
Other	increasing (> 2%)	> 10,000	> 20 years	Microsoft; IBM; QlikView
Other	increasing (> 2%)	> 10,000	> 20 years	SAP
Other	increasing (> 2%)	> 10,000	> 20 years	Microsoft
Other	increasing (> 2%)	1000-5000	> 20 years	Oracle; Microsoft
Other	increasing (> 2%)	1000-5000	> 20 years	Karabina
Other	increasing (> 2%)	1000-5000	> 20 years	IBM COGNOS
Other	increasing (> 2%)	5000-10000	> 20 years	SAP; QlikTech
Other	increasing (> 2%)	500-1000	> 20 years	IBM; Cognos
Production of metal products	increasing (> 2%)	1000-5000	> 20 years	SAP
Production of metal products	increasing (> 2%)	1000-5000	> 20 years	SAP
Financial Services	constant (-2% to +2%)	500-1000	16 - 20 years	Oracle; Unisys

Manufacture of other articles	decreased (<2%)	5000-10000	16 - 20 years	SAP; Uptodata; QlikTech; MicroSoft; IBM
Other	increasing (> 2%)	<250	16 - 20 years	SQL Server Reporting Services; Qlikview; Silvon
Other	constant (-2% to +2%)	<250	11 - 15 years	Microsoft BI tools (SQL, Power BI)
Other	constant (-2% to +2%)	<250	6 - 10 years	IBM
Other	increasing (> 2%)	<250	6 - 10 years	SAP; BusinessObjects
Other	increasing (> 2%)	250-500	6 - 10 years	Oracle; SAP

According to table 6.2 above, SAP, Cognos and Microsoft are invested in by both established companies, and by relatively younger companies, with a large number of employees. This can be seen as a buy-in by larger organisations into established BI products on the market. There is a small presence of newer offerings, such as Qlikview (4%) and Tableau (1%), now being used by large organisations.

6.2.6. Perceived Value

The table below depicts the areas that respondents identified, which are predicted to receive the largest benefit from BI during the next 3 to 5 years.

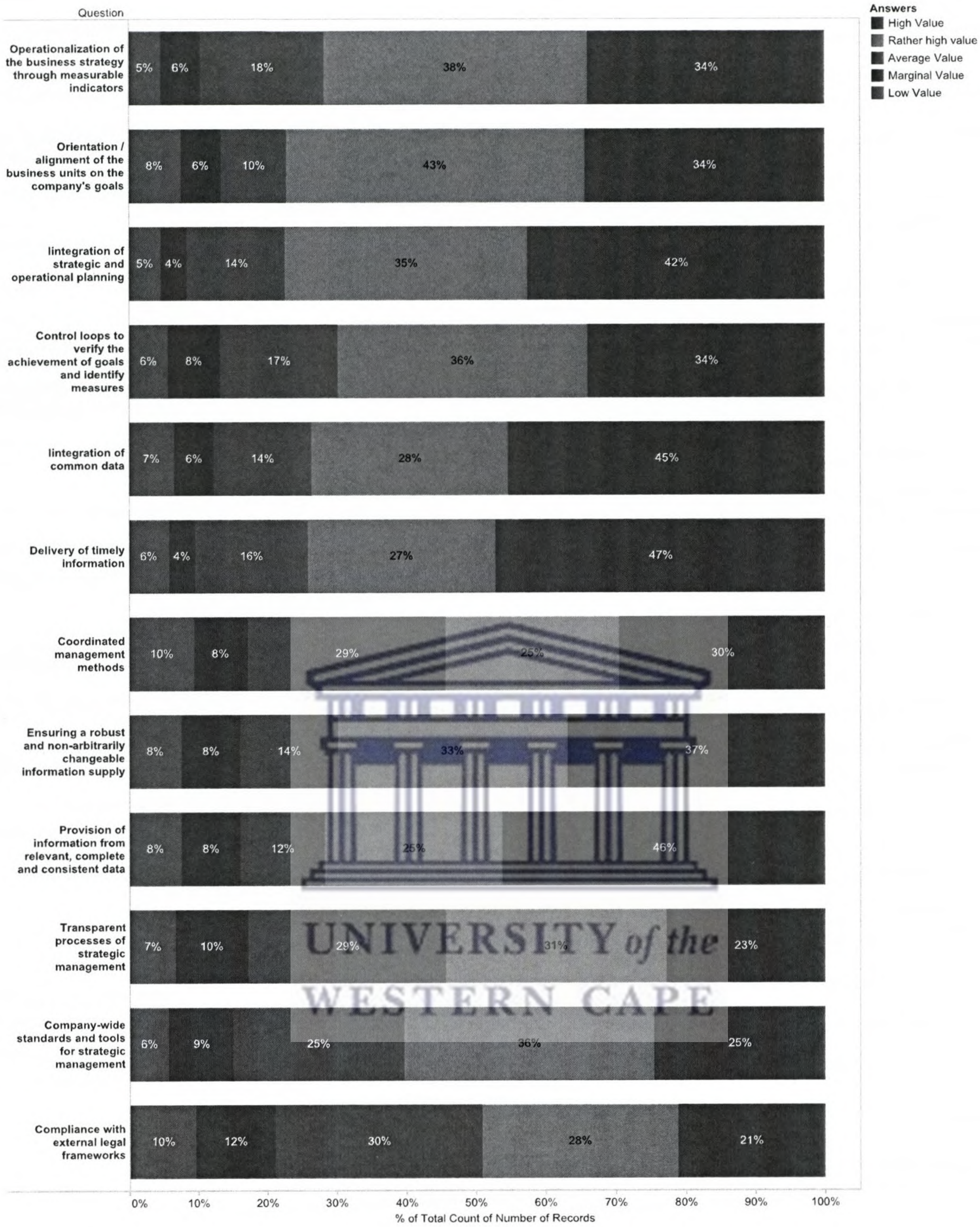


Figure 6.6 - Perceived BI Value

The highest benefit derived from the BI system in the next three to five years, as seen by the respondents was the delivery of timely information (47.12%), followed by the provision of relevant, complete and consistent information (46.23%), and the integration of common data (45.28%). This implies that the highest value derived from BI systems is related to the delivery of quality information (Chapter 3.2.3.1 and Chapter 3.2.3.2).

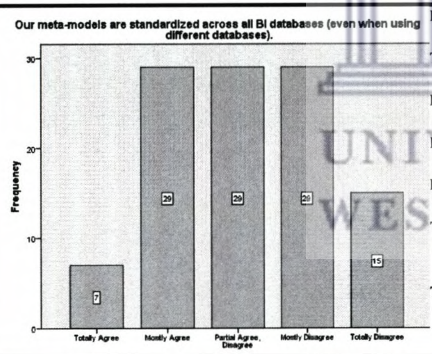
The next significant development is from the benefit derived by integrating operational and strategic planning (42.45%), which amounts to the highest positive score if combined with the "rather high" percentage (77.36%). This means that the respondents see the highest value being derived from the use of information to develop the line-of-sight between strategic and operational planning. The average percentage of high value and rather high value combined amounts to 66.93%, which shows that organisations do see the benefits of BI systems. The benefits could ultimately add value to the organisations during the next three to five years.

6.3. Question Analysis

Each question presented in the online survey was assessed by using a frequency, skewness and kurtosis analysis, as specified in Chapter 5. For each question analysed, the data are presented in a graphical format, depicting the responses on a Likert Scale ranging from "Totally Agree" to "Totally Disagree". The questions address meta-models, master data, functionality availability, as well as usage, BI tool usage, exception reporting, BI documentation, BI projects, data quality, BI architecture, BI processes, BI requirements and user satisfaction.

Question 1 – Meta-model standardisation

Question 1 below represents the analysis of meta-model standardisation in organisations surveyed.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	4	3,5	3,5	3,5
Totally Agree	7	6,2	6,2	9,7
Mostly Agree	29	25,7	25,7	35,4
Partially Agree/Disagree	29	25,7	25,7	61,1
Mostly Disagree	29	25,7	25,7	86,7
Totally Disagree	15	13,3	13,3	100,0
Total	113	100,0	100,0	

Figure 6.7 - Meta-model Standardisation Frequencies

An equal amount of Mostly Agree, Partially Agree/Disagree and Mostly Disagree responses were received, demonstrating a rather even split between agreement and disagreement with regard to the existence of metamodel standardisation in the organisations. The skew towards the negative is the result of the larger number of Totally Disagree responses received (13.3%). The table below shows the skewness and kurtosis, based on the distribution of the responses.

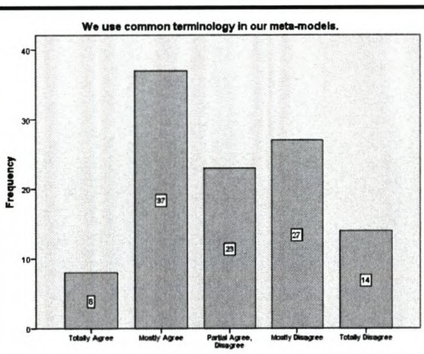
Table 6.3 - Meta-model Standardisation Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
109	4	3,15	3,0	1,15	0,00	0,23	-0,92	0,46

Table 6.3.1 reveals a mean of 3.15, showing a marginal disagreement that their organisations had standardised meta-models on their BI systems. This is supported by a neutral skewness value, as well as a negative kurtosis -0.92, which represents a rather flattened peak, and thus evenly spread responses. This is indicative of the current state of data and information management in many large organisations, where the metadata are still not the main focal point. This lack of standardised meta-models impacts on the quality of information, and thus on the value of the information derived from BI systems (Chapter 3.2.3.1).

Question 2 – Meta-model terminology

The diagram and tables below represent the analysis of meta-model terminology in the organisations surveyed.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	4	3,5	3,5	3,5
Totally Agree	8	7,1	7,1	10,6
Mostly Agree	37	32,7	32,7	43,4
Partially Agree/Disagree	23	20,4	20,4	63,7
Mostly Disagree	27	23,9	23,9	87,6
Totally Disagree	14	12,4	12,4	100,0
Total	113	100,0	100,0	

Figure 6.8 - Meta-model Terminology Frequencies

A large amount of "Mostly-Agree" responses (32.7%) were received to the question of metamodel terminology used, thus showing agreement that common terminology is used in many organisations. The table below shows the skewness and kurtosis, based on the distribution of the responses.

Table 6.4 - Meta-model Terminology Statistics

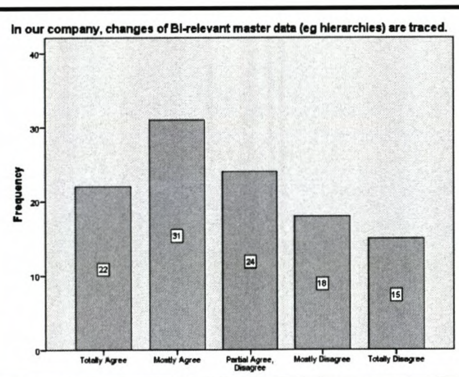
N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
109	4	3,02	3,0	1,19	0,17	0,23	-1,04	0,46

As many as 39.8% of the respondents totally or mostly agreed that the terminology used within their companies' metadata is uniform; while 36.3% totally or mostly disagreed. This is supported by a neutral mean of 3.02, and a slight positive skewness of 0.17. A negative kurtosis of -1.04 shows that the responses received a flattened curve, showing consistent answering of the questions.

This follows a similar pattern to that found in Question 1, where there is a relatively even split between both the meta-model standardisation and the terminology. This again impacts on the quality of information, and may thus impact the value that can be derived from BI systems.

Question 3 – Master Data Traceability

The analysis below is that of master data traceability.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	3	2,7	2,7	2,7
Totally Agree	22	19,5	19,5	22,1
Mostly Agree	31	27,4	27,4	49,6
Partially Agree/Disagree	24	21,2	21,2	70,8
Mostly Disagree	18	15,9	15,9	86,7
Totally Disagree	15	13,3	13,3	100,0
Total	113	100,0	100,0	

Figure 6.9 - Master Data Traceability Frequencies

A large amount of "Mostly Agree" (27.4%) and "Totally agree" (19.5%) responses were received to the question of master-data traceability, showing agreement that master-data traceability does exist. The table below shows the skewness and kurtosis, based on the distribution of the responses.

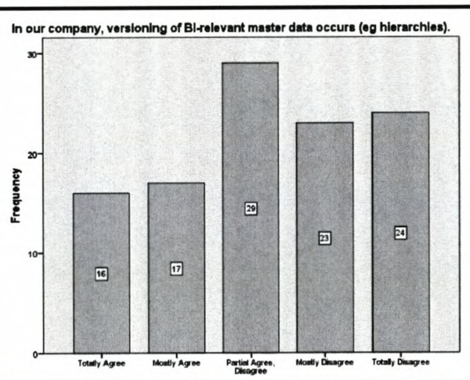
Table 6.5 - Master Data Traceability Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
110	3	2,75	3,0	1,32	0,29	0,23	-1,04	0,46

A large percentage (46.9%) agreed that the master-data are traceable in their organisations. With a mean of 2.75, the responses are leaning towards the positive; however, there is neutrality implied in the skewness of 0.29 and a flattened kurtosis of -1.04. This means that the maintenance of the master-data is seen as being relatively important in organisations; but it is still not as prevalent as it should be. This again may impact the value of BI systems through the quality of information supplied, which is heavily dependent on accurate master data.

Question 4 – Master Data Versioning

The diagram and tables below represent the analysis of master data versioning.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	4	3,5	3,5	3,5
Totally Agree	16	14,2	14,2	17,7
Mostly Agree	17	15,0	15,0	32,7
Partially Agree/Disagree	29	25,7	25,7	58,4
Mostly Disagree	23	20,4	20,4	78,8
Totally Disagree	24	21,2	21,2	100,0
Total	113	100,0	100,0	

Figure 6.10 - Master Data Versioning Frequencies

A large amount of "Mostly Disagree" and "Totally Disagree" responses (41.6%) were received to the question of master-data versioning, indicating agreement that versioning does not on the whole exist. The table below shows the skewness and kurtosis, based on the distribution of the responses.

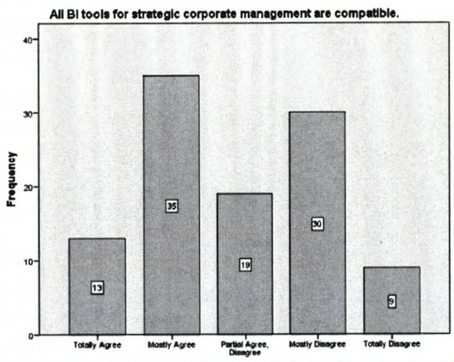
Table 6.6 - Master Data Versioning Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
109	4	3,20	3,0	1,35	-0,19	0,23	-1,08	0,46

As many as 20.4% of the respondents mostly disagreed; while 21.2% totally disagreed that master-data versioning occurs in their organisations. This is supported by a positive mean of 3.20. However, there is a marginal negative skewness of -0.19 and a kurtosis of -1.08, representing a spread of answers away from the mean. This implies that versioning of the master-data is not practised in all the organisations. This again may impact the value of BI systems through the quality of information supplied, which is heavily dependent on the versioning of the master data.

Question 5 – BI Tool Compatibility

Figure 6.11 and table 6.7 below represent the analysis of BI Tool Compatibility.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	7	6,2	6,2	6,2
Totally Agree	13	11,5	11,5	17,7
Mostly Agree	35	31,0	31,0	48,7
Partially Agree/Disagree	19	16,8	16,8	65,5
Mostly Disagree	30	26,5	26,5	92,0
Totally Disagree	9	8,0	8,0	100,0
Total	113	100,0	100,0	

Figure 6.11 - BI Tool Compatibility Frequencies

The largest amount of responses received in terms of BI tool compatibility was "Mostly Agree" (31.0%), thereby indicating agreement that most organisations used compatible BI tools for strategic management. The table below shows the skewness and kurtosis, based on the distribution of the responses.

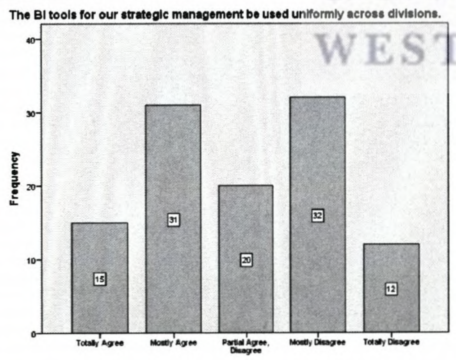
Table 6.7 - BI Compatibility Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
106	7	2,88	3,0	1,20	0,11	0,23	-1,09	0,47

A total of 42.5% of the respondents agreed; while 39% disagreed with regard to the compatibility of BI tools used for strategic corporate management. The marginal positive leaning is seen in the mean of 2.88, and a neutral skewness of 0.11, together with a kurtosis of -1.09. The marginal positivity is indicative of the current BI environment, where large organisations are moving towards similar platforms for strategic corporate management, and therefore easier accessibility to strategic information for decision-making.

Question 6 – Uniform BI Tool Usage

The diagram and tables below represent the analysis of uniform BI Tool Usage.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	3	2,7	2,7	2,7
Totally Agree	15	13,3	13,3	15,9
Mostly Agree	31	27,4	27,4	43,4
Partially Agree/Disagree	20	17,7	17,7	61,1
Mostly Disagree	32	28,3	28,3	89,4
Totally Disagree	12	10,6	10,6	100,0
Total	113	100,0	100,0	

Figure 6.12 - BI Tool Usage Frequencies

The largest amount of responses received in terms of BI tool uniform usage was "Mostly Disagree" (28.3.0%) followed by "Mostly Agree" (27.4%), demonstrating a marginally higher disagreement that most organisations use BI tools uniformly across the organisation for strategic management. The table below shows the skewness and kurtosis based on the distribution of responses.

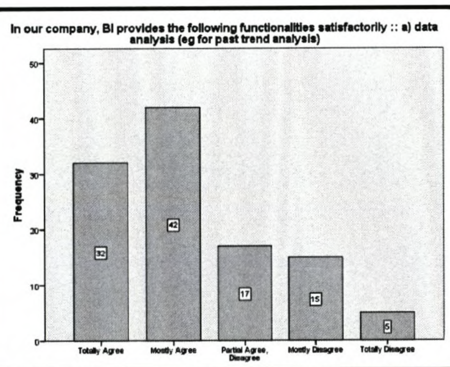
Table 6.8 - BI Tool Usage Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
110	3	2,95	3,0	1,25	0,00	0,23	-1,14	0,46

Similar to the previous question, there is a distribution of 40.7% agreement and 38.9% disagreement on the uniform usage of BI tools for strategic management, with a neutral mean of 2.95, a neutral skewness of 0.00, and a negative kurtosis of -1.14, showing a wider spread of answers away from the mean. With a neutral response overall, it is clear that there is a division in respondents around the uniform usage of BI tools in their organisations. It is apparent that in many organisations, people are using a variety of BI tools, which do impact on the accessibility of information, and in turn may well influence the value addition of BI systems.

Question 7 – Data Analysis Functionality

The information below represents the analysis of Data Analysis Functionality.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	2	1,8	1,8	1,8
Totally Agree	32	28,3	28,3	30,1
Mostly Agree	42	37,2	37,2	67,3
Partially Agree/Disagree	17	15,0	15,0	82,3
Mostly Disagree	15	13,3	13,3	95,6
Totally Disagree	5	4,4	4,4	100,0
Total	113	100,0	100,0	

Figure 6.13 - Data Analysis Frequencies

The respondents agreed (65.5%) that their BI system provides data analysis functionality satisfactorily. The table below shows the skewness and kurtosis, based on the distribution of the responses.

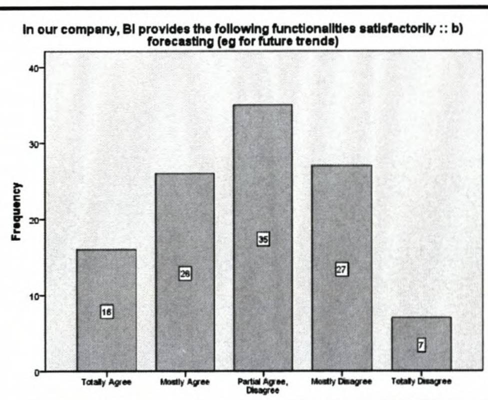
Table 6.9 - Data Analysis Functionality Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
111	2	2,27	2,0	1,15	0,72	0,23	-0,35	0,46

With 65.5%, there is a clear skew towards agreement that adequate data analysis functionality is available in most of the organisations questioned. This is supported by a mean of 2.27, a median of 2.0, and a positive skewness of 0.72. A positive kurtosis of 0.72 shows a relatively peaked response around the median. This is a sign that organisations are choosing to use BI systems as the preferred software for data analysis purposes.

Question 8 – Forecasting Functionality

The diagram and tables below represent the analysis of Forecasting Functionality.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	2	1,8	1,8	1,8
Totally Agree	16	14,2	14,2	15,9
Mostly Agree	26	23,0	23,0	38,9
Partially Agree/Disagree	35	31,0	31,0	69,9
Mostly Disagree	27	23,9	23,9	93,8
Totally Disagree	7	6,2	6,2	100,0
Total	113	100,0	100,0	

Figure 6.14 - Forecasting Functionality Frequencies

From the figure above, it is evident that 31% of the respondents partially agreed/disagreed that their BI system provides forecasting functionality satisfactorily, which indicates a high level of neutrality. The table below shows the skewness and kurtosis, based on the distribution of the responses.

Table 6.10 - Forecasting Functionality Statistics

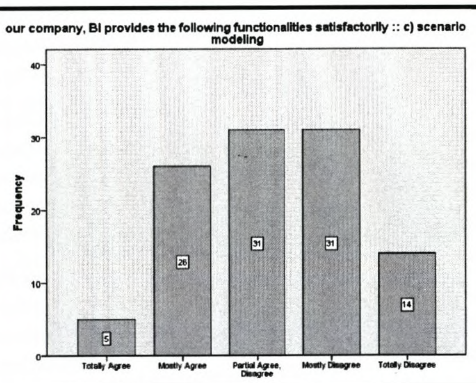
N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
111	2	2,85	3,0	1,14	-0,03	0,23	-0,80	0,46

As many as 37.2% of the respondents agreed that adequate forecasting functionality is available in current BI tools that are deployed in the organisations queried; while 30.1% disagreed. The highest response is a neutral response (31%), which is supported by a mean of 2.85 and a skewness of -0.03.

A kurtosis of -0.83 shows a peak around the mean. This implies that respondents are split on the forecasting functionality being provided. This would affect the ability to provide forecasting functionality within the organisation; and it could also impact the value addition of BI systems.

Question 9 – Scenario Modelling Functionality

Figure 6.15 and table 6.11 below represent the analysis of the question on Scenario Modelling Functionality.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	6	5,3	5,3	5,3
Totally Agree	5	4,4	4,4	9,7
Mostly Agree	26	23,0	23,0	32,7
Partially Agree/Disagree	31	27,4	27,4	60,2
Mostly Disagree	31	27,4	27,4	87,6
Totally Disagree	14	12,4	12,4	100,0
Total	113	100,0	100,0	

Figure 6.15 - Scenario Planning Frequencies

The respondents partially agreed/disagreed (27.4%), and mostly disagreed (27.4%) equally that their BI system provides forecasting functionality satisfactorily. The table below shows the skewness and kurtosis, based on the distribution of the responses.

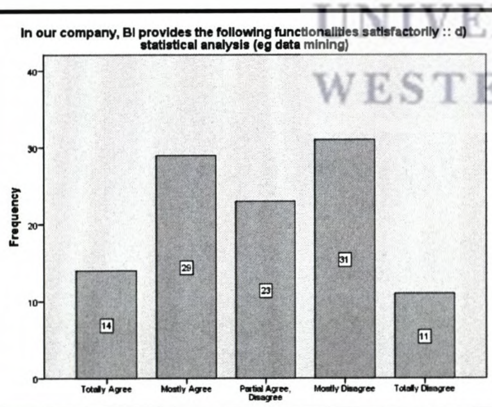
Table 6.11 - Scenario Modelling Functionality Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
107	6	3,21	3,0	1,10	-0,05	0,23	-0,82	0,46

There is a skewness of -0.05 with a mean of 3.21, which suggests that a majority of the respondents (39.8%) do not believe that the BI tools that are deployed in their organisations provide adequate functionality for scenario modelling, which is therefore a limiting factor for organisations; since long-term planning is not adequately catered for; and this could impact negatively on the perceived value addition from their BI systems.

Question 10 – Statistical Analysis Functionality

The diagram and tables below represent the analysis of Statistical Analysis Functionality.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	5	4,4	4,4	4,4
Totally Agree	14	12,4	12,4	16,8
Mostly Agree	29	25,7	25,7	42,5
Partially Agree/Disagree	23	20,4	20,4	62,8
Mostly Disagree	31	27,4	27,4	90,3
Totally Disagree	11	9,7	9,7	100,0
Total	113	100,0	100,0	

Figure 6.16 - Statistical Analysis Frequencies

The respondents mainly disagreed (37.1%) that their BI system provides statistical analysis functionality satisfactorily. The table below shows the skewness and kurtosis, based on the distribution of the responses.

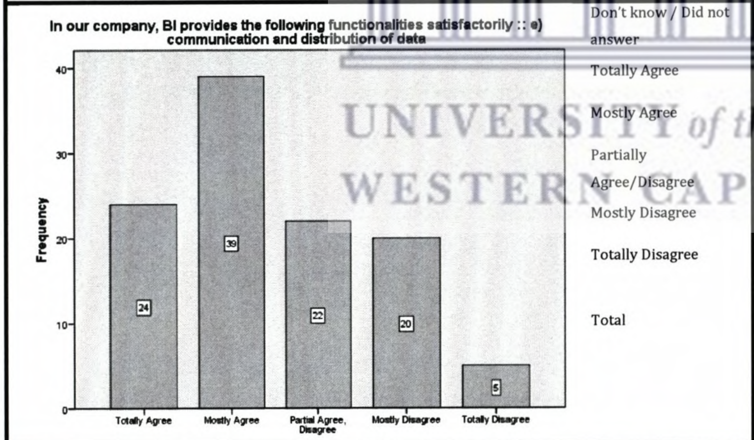
Table 6.12 - Statistical Analysis Functionality Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
108	5	2,96	3,0	1,22	-0,02	0,23	-1,06	0,46

With a skewness of -0.02 and a mean of 2.96, there is a neutral feeling that the BI tools that are deployed in their organisations provide adequate functionality for statistical analysis. This implies that not enough functionality to conduct proper statistical analysis is available in all organisations. And this could hamper the organisation's planning capability, and could impact negatively on the value of BI systems to these organisations.

Question 11 – Communication and Distribution Functionality

The diagram and tables below represent the analysis of the question on Communication and Distribution Functionality.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	3	2,7	2,7	2,7
Totally Agree	24	21,2	21,2	23,9
Mostly Agree	39	34,5	34,5	58,4
Partially Agree/Disagree	22	19,5	19,5	77,9
Mostly Disagree	20	17,7	17,7	95,6
Totally Disagree	5	4,4	4,4	100,0
Total	113	100,0	100,0	

Figure 6.17 - Communication and Distribution Functionality Frequencies

The respondents mostly agreed (34.5%) that their BI system provides adequate communication and distribution of data functionality. The table below shows the skewness and kurtosis, based on the distribution of the responses.

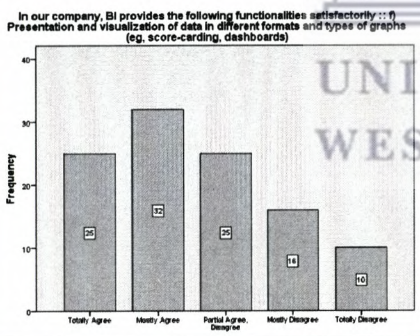
Table 6.13 - Communication and Distribution Functionality Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
110	3	2,48	2,0	1,16	0,43	0,23	-0,76	0,46

As many as 55.7% of the respondents felt that there was adequate communication and data-distribution functionality provided in their BI tools, which is reiterated with a mean of 2.48, a median of 2, and a positive skewness of 0.23. This is a positive sign that information is being shared adequately in the organisations queried, and that it could impact positively on the value added by BI systems.

Question 12 – Presentation and Visualisation Functionality

The information below represents the analysis of Presentation and Visualisation Functionality.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	5	4,4	4,4	4,4
Totally Agree	25	22,1	22,1	26,5
Mostly Agree	32	28,3	28,3	54,9
Sometimes Agree	25	22,1	22,1	77,0
Mostly Disagree	16	14,2	14,2	91,2
Totally Disagree	10	8,8	8,8	100,0
Total	113	100,0	100,0	

Figure 6.18 - Presentation and Visualistion Functionality Frequencies

The respondents mostly agreed (28.3%) that their BI system provides adequate presentation and data visualisation functionality. The table below shows the skewness and kurtosis, based on the distribution of the responses.

Table 6.14 - Presentation and Visualisation Functionality Statistics

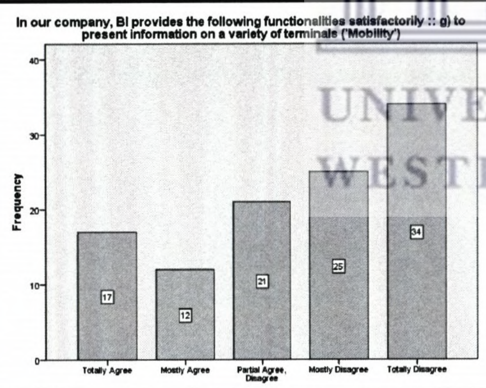
N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of	Kurtosis	Std. Error of

						Skewness		Kurtosis
108	5	2,57	2,0	1,25	0,42	0,23	-0,81	0,46

A total of 50.4% of the respondents answered positively that there was sufficient presentation and visualisation functionality provided in their BI tools, which is reiterated with a mean of 2.57, a median of 2 and a skewness of 0.42. While marginal, this is a positive sign that many organisations provide the facility to ensure that the data analysis conducted can be adequately presented, and could impact positively on the value addition of BI systems.

Question 13 – Mobility Functionality

The diagram and tables below represent the analysis of the Mobility Functionality.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	4	3,5	3,5	3,5
Totally Agree	17	15,0	15,0	18,6
Mostly Agree	12	10,6	10,6	29,2
Partially Agree/Disagree	21	18,6	18,6	47,8
Mostly Disagree	25	22,1	22,1	69,9
Totally Disagree	34	30,1	30,1	100,0
Total	113	100,0	100,0	

Figure 6.19 - Mobility Functionality Frequencies

The highest reponse received was "Totally Disagree" (30.1%), showing that the respondents disagreed that their BI system provides mobility functionality. The table below shows the skewness and kurtosis, based on the distribution of the responses.

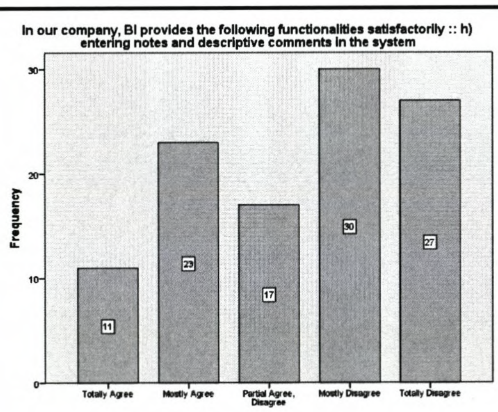
Table 6.15 - Mobility Functionality Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
109	4	3,43	4,0	1,43	-0,47	0,23	-1,09	0,46

Only 25.6% agreed that the BI solutions implemented in their companies allow for multi-platform access to information, with an overwhelming 52.2% disagreeing. This is supported with a mean of 3.43, a median of 4, a standard deviation of 1.43, and a negative skewness of -0.47. This implies that organisations are not equipped to offer multi-platform access to data, which could limit their ability to work from anywhere at any time. This would impact negatively on the accessibility of the data; and it could also negatively influence the value of these BI systems.

Question 14 – Comments Functionality

The information below represents the analysis of the Comments Functionality.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	5	4,4	4,4	4,4
Totally Agree	11	9,7	9,7	14,2
Mostly Agree	23	20,4	20,4	34,5
Partially Agree/Disagree	17	15,0	15,0	49,6
Mostly Disagree	30	26,5	26,5	76,1
Totally Disagree	27	23,9	23,9	100,0
Total	113	100,0	100,0	

Figure 6.20 - Comments Functionality Frequencies

The respondents mostly disagreed (26.5%) that their BI system provides suitable comments functionality. The table below shows the skewness and kurtosis, based on the distribution of the responses.

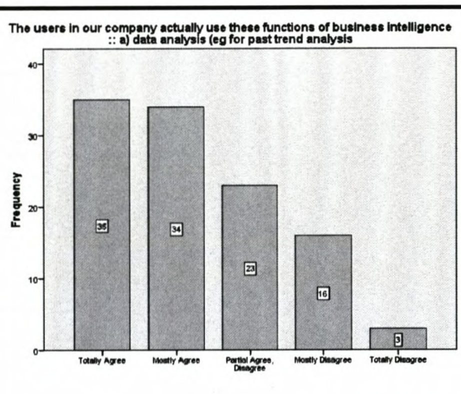
Table 6.16 - Comments Functionality Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
108	5	3,36	4,0	1,34	-0,31	0,23	-1,16	0,46

A total of 30.1% agree that the BI solutions implemented in their companies allow for the entering of notes and comments, with 50.4% disagreeing. This is supported with a mean of 3.36, a median of 4, and a negative skewness of -0.31. It is thus apparent that many users are not able to highlight areas for knowledge sharing with colleagues, which is a limiting factor; and this could impact negatively on the value of BI systems.

Question 15 – Data Analysis Usage

The diagram and tables below represent the analysis of Data Analysis Usage.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	2	1,8	1,8	1,8
Totally Agree	35	31,0	31,0	32,7
Mostly Agree	34	30,1	30,1	62,8
Partially Agree/Disagree	23	20,4	20,4	83,2
Mostly Disagree	16	14,2	14,2	97,3
Totally Disagree	3	2,7	2,7	100,0
Total	113	100,0	100,0	

Figure 6.21 - Data Analysis Usage Frequencies

The highest response received was "Totally Agree" (31.0%), demonstrating that the respondents agreed that their users make satisfatory use of the BI systems data analysis functionality. The table below shows the skewness and kurtosis, based on the distribution of the responses.

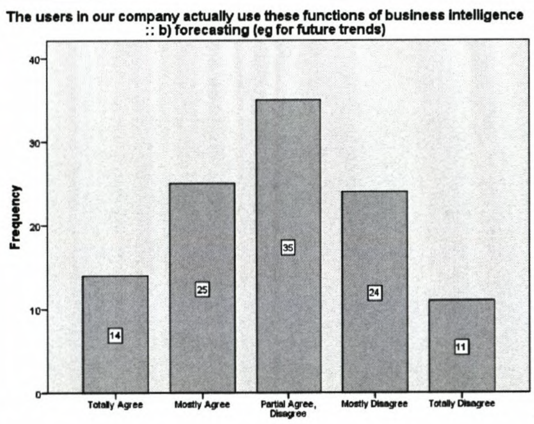
Table 6.17 - Data Analysis Usage Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
111	2	2,26	2,0	1,13	0,53	0,23	-0,70	0,46

As many as 61.1% of the respondents answered positively that their BI system's data analysis functionality was being adequately used in their organisations. This is supported by a mean of 2.26, a median of 2, and a positive skewness of 0.46. A negative kurtosis of -0.70 shows a peak close to the mean. This is a positive indicator that most organisations are providing their users with appropriate data-analysis functionalities to add positively to the perceived value of BI systems.

Question 16 – Forecasting Usage

Figure 6.22 and table 6.18 below represent the analysis of Forecasting Usage.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	4	3,5	3,5	3,5
Totally Agree	14	12,4	12,4	15,9
Mostly Agree	25	22,1	22,1	38,1
Partially Agree/Disagree	35	31,0	31,0	69,0
Mostly Disagree	24	21,2	21,2	90,3
Totally Disagree	11	9,7	9,7	100,0
Total	113	100,0	100,0	

Figure 6.22 - Forecasting Usage Frequencies

The highest response was "Partially Agree/Disagree" (31.0%), showing that the respondents only partially believed that their users make use of the BI systems forecasting functionality satisfactorily. The table below shows the skewness and kurtosis, based on the distribution of the responses.

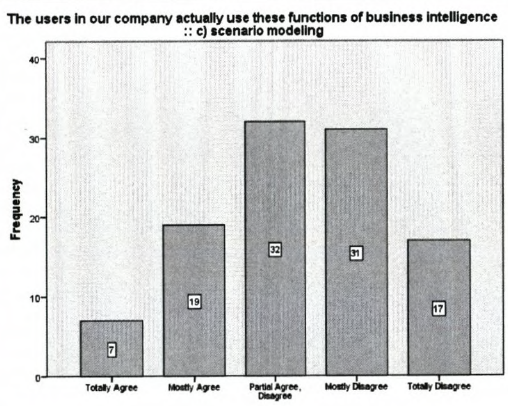
Table 6.18 - Forecasting Usage Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
109	4	2,94	3,0	1,17	0,02	0,23	-0,78	0,46

A total of 30.9% of the respondents answered that their BI system's forecasting functionality is not being adequately used in their organisations; while 34.5% agreed that it is; and 31.0% remained neutral on the usage. This neutral perspective is supported by a mean of 2.94, a median of 3, and a skewness of 0.02. This demonstrates that the organisations queried are split on the usage of forecasting functionalities, which limits planning capabilities, and may impact on the value added by the BI systems.

Question 17 – Scenario Modelling Usage

The diagram and tables below represent the analysis of the question on Scenario Modelling Usage.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	7	6,2	6,2	6,2
Totally Agree	7	6,2	6,2	12,4
Mostly Agree	19	16,8	16,8	29,2
Partially Agree/Disagree	32	28,3	28,3	57,5
Mostly Disagree	31	27,4	27,4	85,0
Totally Disagree	17	15,0	15,0	100,0
Total	113	100,0	100,0	

Figure 6.23 - Scenario Modelling Frequencies

The respondents partially agreed/disagreed (28.3%), and mostly disagree

(27.4%) that their users make use of the BI systems scenario-planning functionality. The table below shows the skewness and kurtosis, based on the distribution of the responses.

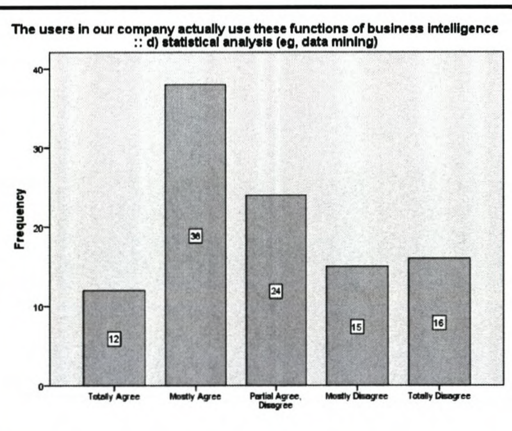
Table 6.19 - Scenario Modelling Usage Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
106	7	3,30	3,0	1,14	-0,23	0,23	-0,69	0,47

A total of 42.4% of the respondents answered that their BI system's scenario-planning functionality is not adequately used in their organisations. This is supported by a mean of 3.30, a median of 3, and a negative skewness of -0.23. This demonstrates that most of the organisations queried do not use scenario-planning functionalities, which is a limiting factor for company planning, and could impact negatively on the organisation's value addition from its BI system.

Question 18 – Statistical Analysis Usage

The information below represents the analysis of the question on Statistical Analysis Usage.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	8	7,1	7,1	7,1
Totally Agree	12	10,6	10,6	17,7
Mostly Agree	38	33,6	33,6	51,3
Partially Agree/Disagree	24	21,2	21,2	72,6
Mostly Disagree	15	13,3	13,3	85,8
Totally Disagree	16	14,2	14,2	100,0
Total	113	100,0	100,0	

Figure 6.24 - Statistical Analysis Usage Frequencies

The respondents mostly agreed (33.6%) that their users use the BI system's statistical-analysis functionality. The table below shows the skewness and kurtosis, based on the distribution of the responses.

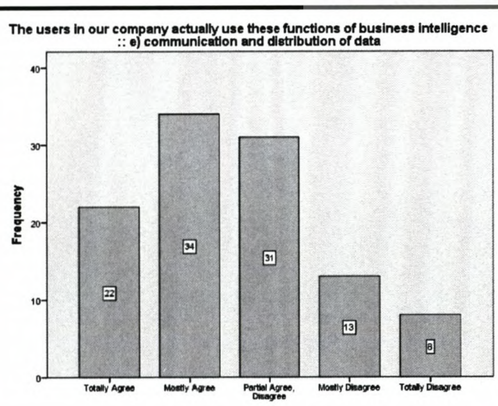
Table 6.20 - Statistical Analysis Usage Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
105	8	2,86	3,0	1,25	0,40	0,24	-0,90	0,47

With the largest number of respondents agreeing (44.2%), there is a slight leaning towards agreeing that their BI system's statistical-analysis functionality is adequately used in their organisations. This is supported by a mean of 2.86, a median of 2, and a positive skewness of 0.40. This demonstrates that the majority of organisations queried do use the statistical-analysis functionality of their BI system, which might well impact positively on the value of BI systems.

Question 19 – Communication and Distribution Usage

The diagram and tables below represent the analysis of the Communication and Distribution Usage.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	5	4,4	4,4	4,4
Totally Agree	22	19,5	19,5	23,9
Mostly Agree	34	30,1	30,1	54,0
Partially Agree/Disagree	31	27,4	27,4	81,4
Mostly Disagree	13	11,5	11,5	92,9
Totally Disagree	8	7,1	7,1	100,0
Total	113	100,0	100,0	

Figure 6.25 - Communication and Distribution Usage Frequencies

The respondents were mostly positive (30.1% mostly agreed and 19.5% totally agreed) that their users make use of the BI systems communication and data-distribution functionalities. The table below shows the skewness and kurtosis, based on the distribution of responses.

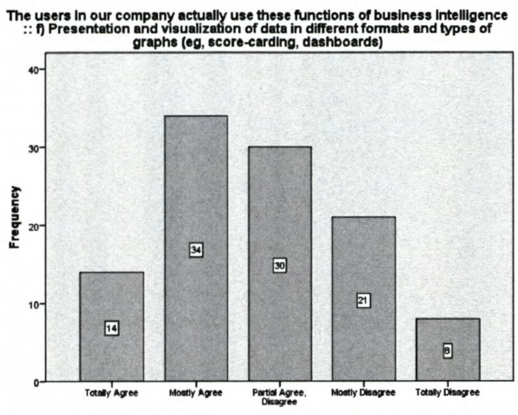
Table 6.21 - Communication and Distribution Usage Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
108	5	2,55	2,0	1,16	0,45	0,23	-0,50	0,46

The largest number of respondents agreed (49.6%), with the second highest being partially agreed/disagreed (27.4%). This results in a slight skew towards agreeing (0.45) that their BI system's communication and distribution of data functionality is adequately used in their organisations. This is supported by a mean of 2.55 and a median of 2. The above demonstrates that the majority of organisations queried do use the communication and distribution of data functionality of their BI system, which may impact positively on the value of BI systems.

Question 20 – Presentation and Visualisation Usage

The diagram and tables below represent the analysis of the Presentation and Visualisation Usage.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	6	5,3	5,3	5,3
Totally Agree	14	12,4	12,4	17,7
Mostly Agree	34	30,1	30,1	47,8
Partially Agree/Disagree	30	26,5	26,5	74,3
Mostly Disagree	21	18,6	18,6	92,9
Totally Disagree	8	7,1	7,1	100,0
Total	113	100,0	100,0	

Figure 6.26 - Presentation and Visualisation Usage Frequencies

The respondents mostly agree (30.1%) that their users make use of the BI systems presentation and data-visualisation functionalities. The table below shows the skewness and kurtosis, based on the distribution of the responses.

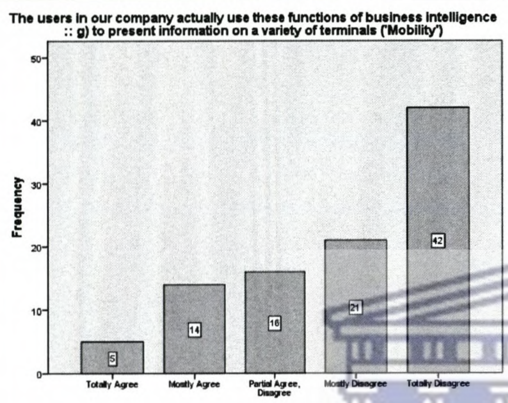
Table 6.22 - Presentation and Visualisation Usage Statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
107	6	2,77	3,0	1,14	0,24	0,23	-0,73	0,46

As many as 42.5% of the respondents answered that their BI system's presentation and visualisation of data functionality was being adequately used in their organisations. This is supported by a mean of 2.77, a median of 3, and a skewness of 0.24. The above demonstrates that the organisations queried do marginally use the presentation and visualisation of data functionalities, which enhance the ability to share knowledge effectively, and may well impact positively on the value of BI systems.

Question 21 – Mobility Usage

The information below represents the analysis of Mobility Usage.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	15	13,3	13,3	13,3
Totally Agree	5	4,4	4,4	17,7
Mostly Agree	14	12,4	12,4	30,1
Partially Agree/Disagree	16	14,2	14,2	44,2
Mostly Disagree	21	18,6	18,6	62,8
Totally Disagree	42	37,2	37,2	100,0
Total	113	100,0	100,0	

Figure 6.27 - Mobility Usage Frequencies

The highest response received was "Totally Disagree" (37.2%), with the respondents disagreeing that their users make use of the BI systems' mobility functionality. The table below shows the skewness and kurtosis, based on the distribution of the responses.

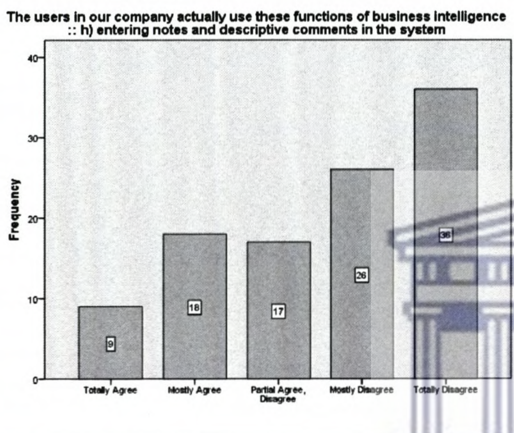
Table 6.23 - Mobility Usage statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
98	15	3,83	4,0	1,27	-0,72	0,24	-0,71	0,48

A total of 55.8% of the respondents answered that their BI system's information mobility functionality is not being adequately used in their organisations. This is supported by a mean of 3.83, a median of 4, and a negative skewness of -0.72. This demonstrates that the organisations queried do not have information-mobility functionalities in place, which the users find appropriate, or could make use of; and this could impact negatively on the perceived value addition of BI systems.

Question 22 – Comments Usage

The diagram and tables below represent the analysis of the Comments Usage.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	7	6,2	6,2	6,2
Totally Agree	9	8,0	8,0	14,2
Mostly Agree	18	15,9	15,9	30,1
Partially Agree/Disagree	17	15,0	15,0	45,1
Mostly Disagree	26	23,0	23,0	68,1
Totally Disagree	36	31,9	31,9	100,0
Total	113	100,0	100,0	

Figure 6.28 - Comments Usage Frequencies

The highest response received was "Totally Disagree" (31.9%), showing that the respondents did not believe that their users make use of the BI system's comments functionality. The table below shows the skewness and kurtosis, based on the distribution of the responses.

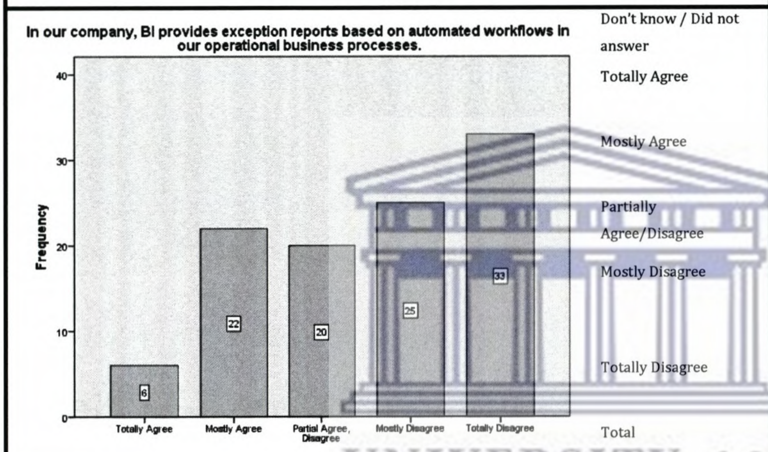
Table 6.24 - Comments Usage statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
106	7	3,58	4,0	1,34	-0,51	0,23	-1,00	0,47

A total of 54.9% of the respondents answered that their BI system's notes and descriptive comments functionality are not being adequately used in their organisations. This is supported by a mean of 3.58, a median of 4.0, and a negative skewness of -0.51. This demonstrates that the organisations queried do not have notes and descriptive comments functionalities in place that the users would find appropriate, or make use of; and this might impact negatively on the value of BI systems.

Question 23 – Automated Operational Workflow Exception Reporting

The diagram and tables below represent the analysis of Automated Operational Workflow Exception Reporting.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	7	6,2	6,2	6,2
Totally Agree	6	5,3	5,3	11,5
Mostly Agree	22	19,5	19,5	31,0
Partially Agree/Disagree	20	17,7	17,7	48,7
Mostly Disagree	25	22,1	22,1	70,8
Totally Disagree	33	29,2	29,2	100,0
Total	113	100,0	100,0	

Figure 6.29 - Automated Operational Workflow Exception Reporting Frequencies

The highest response was "Totally Disagree" (29.2%), with the respondents disagreeing that exception reports based on automated workflows in their operational business processes are provided by their BI systems. The table below shows the skewness and kurtosis, based on the distribution of the responses.

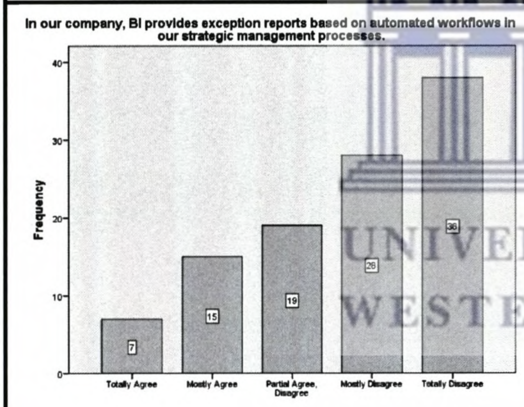
Table 6.25 - Automated operational workflow exception reporting statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
106	7	3,54	4,0	1,28	-0,35	0,23	-1,12	0,47

As many as 51.3% of the respondents answered that their BI system did not provide exception reporting for automated operational-process workflows. This is supported by a mean of 3.54, a median of 4.0, and a negative skewness of -0.35. A kurtosis of -1.12 demonstrates that there is a marked peak around the mean. This demonstrates that the organisations queried do not have exception reporting in place for automated workflows in their operational-business processes, which is a limiting factor on efficiency, and could impact the value add that BI systems provide from an automated-reporting perspective.

Question 24 – Automated Strategic Workflow Exception Reporting

Question 24 below represent the analysis of Automated Strategic Workflow Exception Reporting.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	6	5,3	5,3	5,3
Totally Agree	7	6,2	6,2	11,5
Mostly Agree	15	13,3	13,3	24,8
Partially Agree/Disagree	19	16,8	16,8	41,6
Mostly Disagree	28	24,8	24,8	66,4
Totally Disagree	38	33,6	33,6	100,0
Total	113	100,0	100,0	

Figure 6.30 - Automated Strategic Workflow Exception Reporting Frequencies

The highest response was "Totally Disagree" (33.6%), showing that the respondents disagreed that exception reports, based on automated workflows in their strategic business processes are provided by their BI systems. The table below shows the skewness and kurtosis, based on the distribution of the responses.

Table 6.26 - Automated Strategic Workflow Exception Reporting statistics

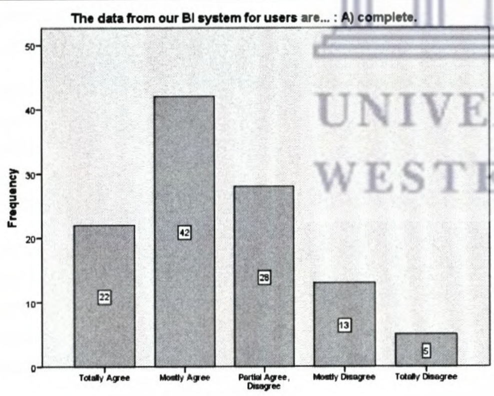
N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of	Kurtosis	Std. Error of

						Skewness		Kurtosis
107	6	3,70	4,0	1,27	-0,63	0,23	-0,73	0,46

A total of 58.4% of the respondents answered that their BI system did not provide exception reporting for automated strategic management-process workflows. This is supported by a mean of 3.70, a median of 4.0, and a negative skewness of -0.63. The negative response demonstrates that the organisations queried do not have exception reporting in place for automated workflows in their strategic-management business processes, which is limiting from a company's planning-and-efficiency perspective, and may impact the value addition that BI systems provide from an automated reporting perspective.

Question 25 – Data Completeness

The diagram and tables below represent the analysis of Data Completeness.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	3	2,7	2,7	2,7
Totally Agree	22	19,5	19,5	22,1
Mostly Agree	42	37,2	37,2	59,3
Partially Agree/Disagree	28	24,8	24,8	84,1
Mostly Disagree	13	11,5	11,5	95,6
Totally Disagree	5	4,4	4,4	100,0
Total	113	100,0	100,0	

Figure 6.31 - Data Completeness Frequencies

The respondents mostly agreed (37.2%) that the data provided by their BI systems to users is complete. The table below shows the skewness and the kurtosis, based on the distribution of the responses.

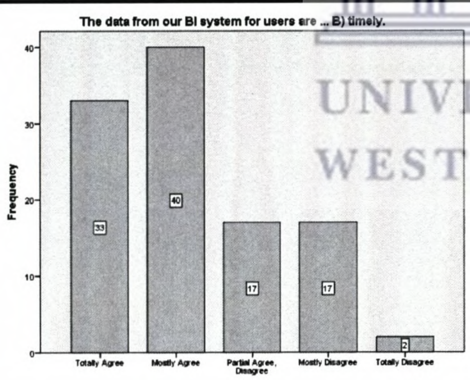
Table 6.27 - Data Completeness statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
110	3	2,43	2,0	1,08	0,55	0,23	-0,27	0,46

The largest number of respondents agreed (56.7%) that the data provided by their BI systems to users were complete. This is supported by a mean of 2.43, a median of 2, and a positive skewness of 0.55. This points to respondents trusting that the data supplied by their BI system are complete, and may impact positively on the value of BI systems from an information-quality perspective.

Question 26 – Data Timeliness

The diagram and tables below represent the analysis of the question on Data Timeliness.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	4	3,5	3,5	3,5
Totally Agree	33	29,2	29,2	32,7
Mostly Agree	40	35,4	35,4	68,1
Partially Agree/Disagree	17	15,0	15,0	83,2
Mostly Disagree	17	15,0	15,0	98,2
Totally Disagree	2	1,8	1,8	100,0
Total	113	100,0	100,0	

Figure 6.32 - Data Timeliness Frequencies

The respondents mostly agreed (35.4%) that the data provided by their BI systems to users is timely. The table below shows the skewness and kurtosis, based on the distribution of the responses.

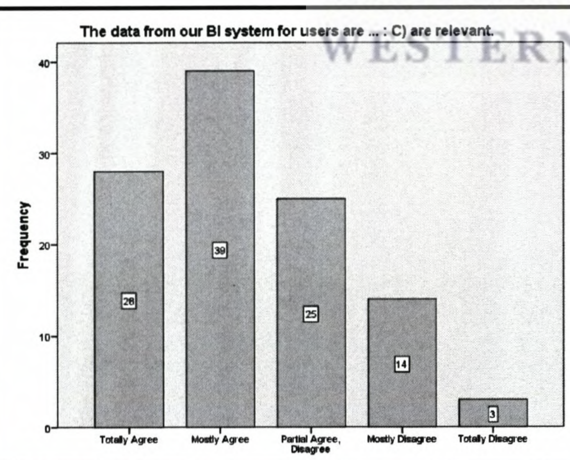
Table 6.28 - Data Timeliness statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
109	4	2,22	2,0	1,10	0,61	0,23	-0,62	0,46

The largest number of respondents agreed (64.6%) that the data provided by their BI systems to users were timely. This is supported by a mean of 2.22, a median of 2, and a positive skewness of 0.61. The positive response received points to respondents trusting that the data supplied by their BI system were timeous, and could impact positively on the value of BI systems from an information-quality perspective.

Question 27 – Data Relevance

The information below represents the analysis of the question on Data Relevance.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	4	3,5	3,5	3,5
Totally Agree	28	24,8	24,8	28,3
Mostly Agree	39	34,5	34,5	62,8
Partially Agree/Disagree	25	22,1	22,1	85,0
Mostly Disagree	14	12,4	12,4	97,3
Totally Disagree	3	2,7	2,7	100,0
Total	113	100,0	100,0	

Figure 6.33 - Data Relevance Frequencies

The respondents mostly agreed (34.5%) that the data provided by their BI systems to users are relevant. The table below shows the skewness and kurtosis, based on the distribution of the responses

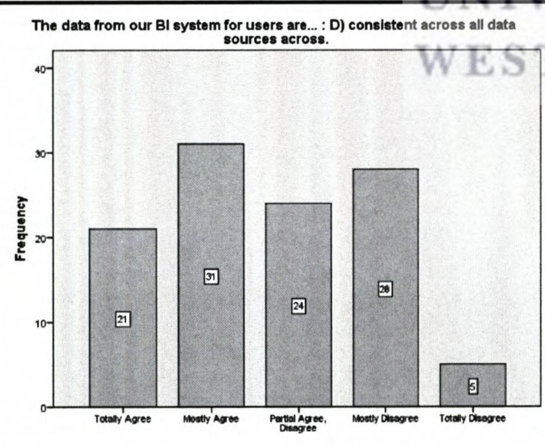
Table 6.29 - Data Relevance statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
109	4	2,31	2,0	1,08	0,52	0,23	-0,48	0,46

The largest number of respondents agreed (59.3%) that the data provided by their BI systems to users were relevant. This is supported by a mean of 2.31, a median of 2, and a positive skewness of 0.52. The positive response points to the respondents trusting that the data supplied by their BI system are relevant; and they could impact positively on the value of BI systems from an information-quality perspective.

Question 28 – Data consistency

The diagram and tables below represent the analysis of the question on Data consistency.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	4	3,5	3,5	3,5
Totally Agree	21	18,6	18,6	22,1
Mostly Agree	31	27,4	27,4	49,6
Partially Agree/Disagree	24	21,2	21,2	70,8
Mostly Disagree	28	24,8	24,8	95,6
Totally Disagree	5	4,4	4,4	100,0
Total	113	100,0	100,0	

Figure 6.34 - Data consistency Frequencies

The respondents mostly agreed (27.4%) that data provided by their BI systems to users are consistent. The table below shows the skewness and kurtosis, based on the distribution of the responses.

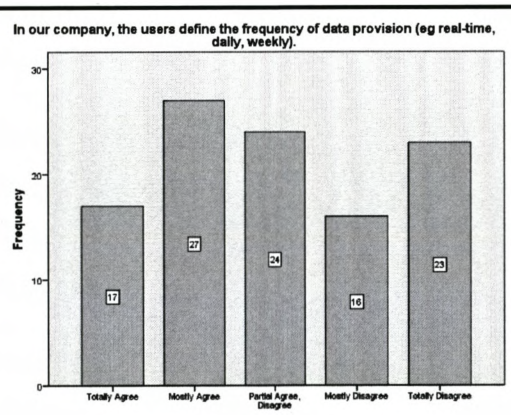
Table 6.30 - Data consistency statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
109	4	2,68	3,0	1,19	0,11	0,23	-1,08	0,46

The largest number of respondents agreed (46.0%) that the data provided by their BI systems to users across all data sources are consistent. However, a large number of respondent partially agreed/disagreed (21.2%); and they mostly disagreed (24.8%), leading to an overall slight leaning towards a positive result. This is supported by a mean of 2.68, a median of 3, and a skewness of 0.23. The positive response points to the respondents marginally trusting that the data supplied by their BI system are consistent across the data sources; and this could impact on the value of the BI systems.

Question 29 – Data Frequency

The diagram and tables below represent the analysis of Data Frequency.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	6	5,3	5,3	5,3
Totally Agree	17	15,0	15,0	20,4
Mostly Agree	27	23,9	23,9	44,2
Partially Agree/Disagree	24	21,2	21,2	65,5
Mostly Disagree	16	14,2	14,2	79,6
Totally Disagree	23	20,4	20,4	100,0
Total	113	100,0	100,0	

Figure 6.35 - Data Frequency Frequencies

The respondents mostly agreed (23.9%) that the frequency of the data provided by their BI systems is defined by the users. However, a large number (20.4%) totally disagreed that this is the situation. The table below shows the skewness and kurtosis, based on the distribution of the responses.

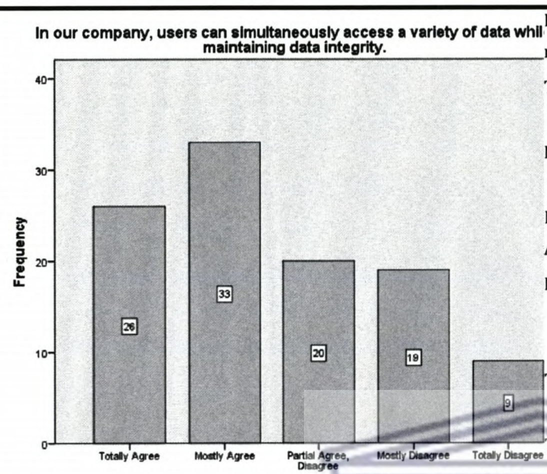
Table 6.31 - Data Frequency statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
107	6	3,01	3,0	1,38	0,11	0,23	-1,23	0,46

A large number of the respondents agreed (38.9%); while a number disagreed (34.6%) that the data provided by their BI systems to users are according to the user-defined frequencies. Only 21.2% of the respondents partially agreed/disagreed, leading to a neutral result overall. This is supported by a mean of 3.01, a median of 3, and a skewness of 0.23. This indicates that the respondents marginally believe that their BI system provides data, in accordance with user-frequency demands; and this could impact on the perceived value of BI systems.

Question 30 – Data Integrity

Question 30 represents the analysis of Data Integrity.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	6	5,3	5,3	5,3
Totally Agree	26	23,0	23,0	28,3
Mostly Agree	33	29,2	29,2	57,5
Partially Agree/Disagree	20	17,7	17,7	75,2
Mostly Disagree	19	16,8	16,8	92,0
Totally Disagree	9	8,0	8,0	100,0
Total	113	100,0	100,0	

Figure 6.36 - Data Integrity Frequencies

The respondents mostly agreed (29.2%) that their BI systems maintain data integrity at all times. The table below shows the skewness and kurtosis, based on the distribution of the responses.

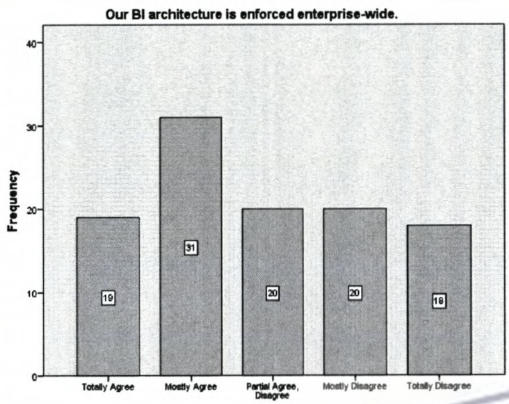
Table 6.32 - Data Integrity statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
107	6	2,55	2,0	1,27	0,42	0,23	-0,92	0,46

The largest number of respondents agreed (52.2%) that users can simultaneously access a variety of data, while ensuring data integrity. This is supported by a mean of 2.55, a median of 2, and a positive skewness of 0.42. This demonstrates the respondents' trust that the data supplied by their BI system would maintain their integrity; since the user simultaneously accesses a variety of data, which may impact positively on the perceived value of BI systems from an information-quality perspective.

Question 31 – Standard BI Architecture

The diagram and tables below represent the analysis of Standard BI Architecture.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	5	4,4	4,4	4,4
Totally Agree	19	16,8	16,8	21,2
Mostly Agree	31	27,4	27,4	48,7
Partially Agree/Disagree	20	17,7	17,7	66,4
Mostly Disagree	20	17,7	17,7	84,1
Totally Disagree	18	15,9	15,9	100,0
Total	113	100,0	100,0	

Figure 6.37 - Standard BI Architecture Frequencies

The respondents mostly agreed (27.4%) that a standard BI architecture is enforced across their organisation. The table below shows the skewness and kurtosis, based on the distribution of the responses.

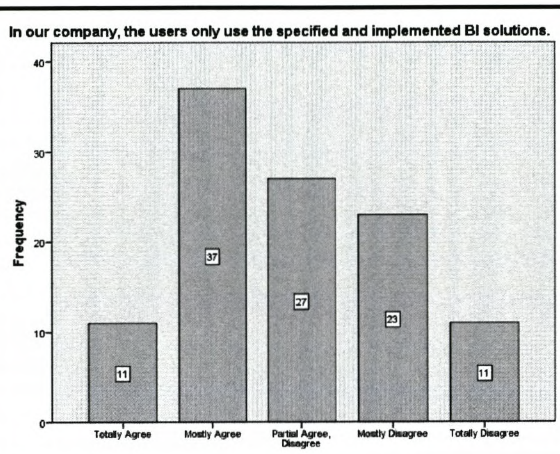
Table 6.33 - Standard BI Architecture statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
108	5	2,88	3,0	1,36	0,20	0,23	-1,20	0,46

The largest number of respondents agreed (44.2%) that a common BI architecture is enforced across their organisation. This is supported by a mean of 2.88, a median of 3, and a skewness of 0.20, which implies an overall neutral result with a slight skew towards positivity. The positive response received implies that most organisations questioned marginally agreed that a common BI architecture is enforced across the organisation.

Question 32 – Prescribed BI Solution Usage

The diagram and tables below represent the analysis of Prescribed BI Solution Usage.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	4	3,5	3,5	3,5
Totally Agree	11	9,7	9,7	13,3
Mostly Agree	37	32,7	32,7	46,0
Partially Agree/Disagree	27	23,9	23,9	69,9
Mostly Disagree	23	20,4	20,4	90,3
Totally Disagree	11	9,7	9,7	100,0
Total	113	100,0	100,0	

Figure 6.38 - Prescribed BI Solution Usage Frequencies

The respondents mostly agreed (32.7%) that only specified BI solutions are made use of in their organisations. The table below shows the skewness and kurtosis, based on the distribution of the responses.

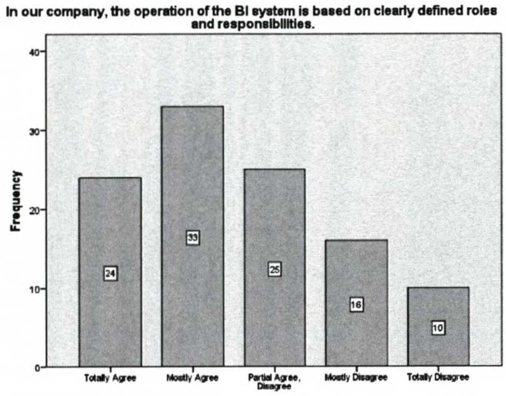
Table 6.34 - Prescribed BI Solution Usage statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
109	4	2,87	3,0	1,16	0,25	0,23	-0,85	0,46

The largest number of respondents agreed (42.4%) that the users in their organisations only use the implemented BI solutions; however, only marginally, so that 23.9% partially agreed/disagreed and 30.1% disagreed. This is supported by a mean of 2.87, a median of 3, and a skewness of 0.25. This shows that the respondents only marginally believed that specified BI solutions within their organisations are adhered to.

Question 33 – BI Roles and Responsibilities

The information below represents the analysis of the question on BI Roles and Responsibilities.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	5	4,4	4,4	4,4
Totally Agree	24	21,2	21,2	25,7
Mostly Agree	33	29,2	29,2	54,9
Partially Agree/Disagree	25	22,1	22,1	77,0
Mostly Disagree	16	14,2	14,2	91,2
Totally Disagree	10	8,8	8,8	100,0
Total	113	100,0	100,0	

Figure 6.39 - BI Roles and Responsibilities Frequencies

The respondents mostly agreed (29.2%) that the operation of BI systems in their organisations are based on clearly defined BI roles and responsibilities. The table below shows the skewness and kurtosis, based on the distribution of the responses.

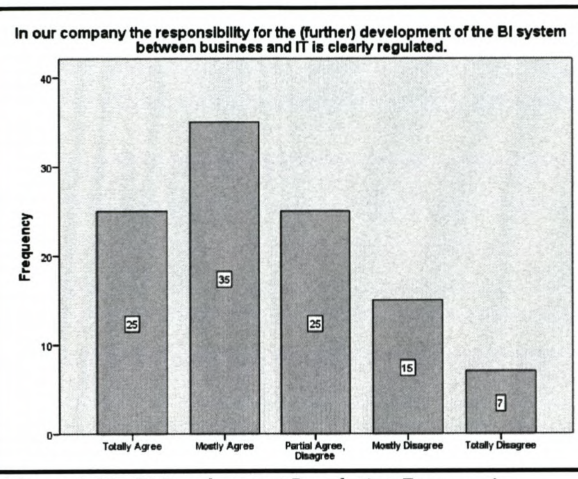
Table 6.35 - BI Roles and Responsibilities statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
108	5	2,58	2,0	1,25	0,43	0,23	-0,79	0,46

Most of the respondents agreed (51.3%) that the operation of their organisations BI systems was based on clearly defined BI roles and responsibilities. This is shown in a mean of 2.58, a median of 2, and a skewness index of 0.43. This means that most of the respondents agreed that there are clear BI operational roles and responsibilities specified in their organisations; and these could impact positively on the value of BI systems from a cultural and capabilities' perspective.

Question 34 – BI Development Regulation

The diagram and tables below represent the analysis of BI Development Regulation.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	6	5,3	5,3	5,3
Totally Agree	25	22,1	22,1	27,4
Mostly Agree	35	31,0	31,0	58,4
Partially Agree/Disagree	25	22,1	22,1	80,5
Mostly Disagree	15	13,3	13,3	93,8
Totally Disagree	7	6,2	6,2	100,0
Total	113	100,0	100,0	

Figure 6.40 - BI Development Regulation Frequencies

The respondents mostly agreed (31.0%) that the responsibility for the development of the BI systems is clearly regulated between the business and IT. The table below shows the skewness and kurtosis, based on the distribution of the responses.

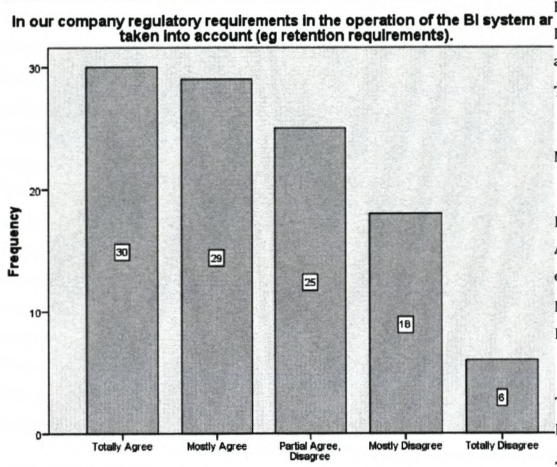
Table 6.36 - BI Development Regulation statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
107	6	2,48	2,0	1,18	0,49	0,23	-0,62	0,46

As many as 53.1% of the respondents agreed that the responsibility for further development of the organisation's BI systems, between IT and the business, is clearly demarcated and regulated. This is reinforced by a mean of 2.48, a median of 2, and a skewness index of 0.49. This implies that the control of BI development is in place, and adhered to, which might impact positively on the value of BI systems from a cultural and capabilities' perspective.

Question 35 – BI Regulatory Requirements

The information below represents the analysis of the question on BI Regulatory Requirements.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	5	4,4	4,4	4,4
Totally Agree	30	26,5	26,5	31,0
Mostly Agree	29	25,7	25,7	56,6
Partially Agree/Disagree	25	22,1	22,1	78,8
Mostly Disagree	18	15,9	15,9	94,7
Totally Disagree	6	5,3	5,3	100,0
Total	113	100,0	100,0	

Figure 6.41 - BI Regulatory Requirements Frequencies

The highest response was "Totally Agree" (26.5%) demonstrating that respondents believe that regulatory requirements such as retention periods are taken into account in the operation of their organisation's BI system. The table below shows the skewness and kurtosis based on the distribution of responses

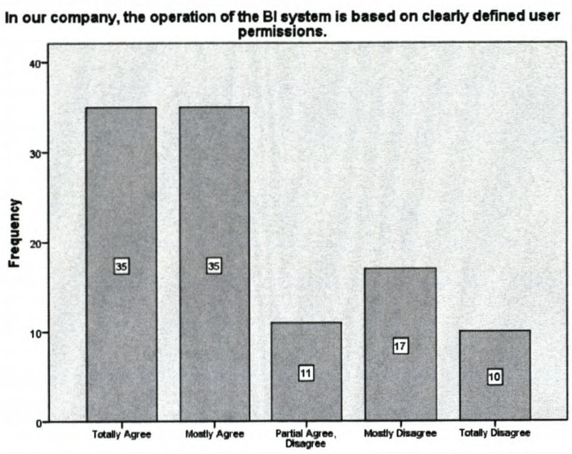
Table 6.37 - BI Regulatory Requirements statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
108	5	2,45	2,0	1,22	0,39	0,23	-0,87	0,46

A total of 52.2% of the respondents agreed that the regulatory requirements, such as retention schedules, had been taken into account in their organisation's BI system. This is reinforced by a mean of 2.45, a median of 2, and a skewness index of 0.39. The positive response received implies that most organisations do take regulations into account when implementing BI systems, which may impact positively on the value addition from a BI systems' perspective.

Question 36 – User Permissions

The diagram and tables below represent the analysis of the question on User Permissions.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	5	4,4	4,4	4,4
Totally Agree	35	31,0	31,0	35,4
Mostly Agree	35	31,0	31,0	66,4
Partially Agree/Disagree	11	9,7	9,7	76,1
Mostly Disagree	17	15,0	15,0	91,2
Totally Disagree	10	8,8	8,8	100,0
Total	113	100,0	100,0	

Figure 6.42 - User Permissions Frequencies

The respondents mainly and totally agreed (31%) and mostly agreed (31.0%) that the operation of the BI system in their organisation is based on clearly defined user permissions. The table below shows the skewness and kurtosis, based on the distribution of the responses.

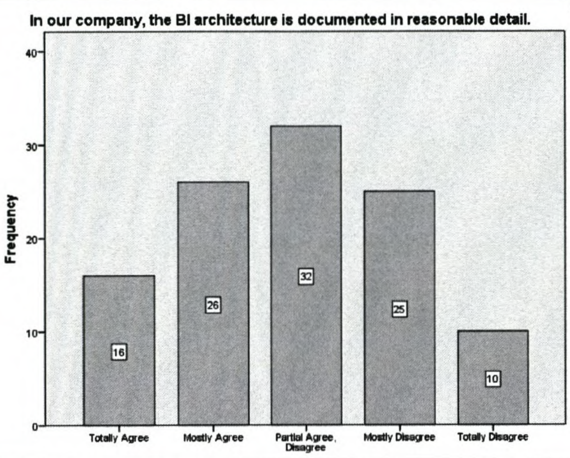
Table 6.38 - User Permissions statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
108	5	2,37	2,0	1,33	0,67	0,23	-0,80	0,46

A total of 62% of the respondents agreed that the operation of their organisation's BI system is clearly based on defined user permissions. This is reinforced by a mean of 2.37, a median of 2, and a skewness index of 0.67. Therefore, most organisations agreed that the management of access to data and the BI system is in place and effective, which might impact BI system value-addition positively from a cultural and capabilities' perspective.

Question 37 – BI Architecture Documentation

The diagram and tables below represent the analysis of the question on BI Architecture Documentation.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	4	3,5	3,5	3,5
Totally Agree	16	14,2	14,2	17,7
Mostly Agree	26	23,0	23,0	40,7
Partially Agree/Disagree	32	28,3	28,3	69,0
Mostly Disagree	25	22,1	22,1	91,2
Totally Disagree	10	8,8	8,8	100,0
Total	113	100,0	100,0	

Figure 6.43 - BI Architecture Documentation Frequencies

The respondents partially agreed/disagreed (28.3%) that their organisation's BI architecture is documented in reasonable detail. The table below shows the skewness and kurtosis, based on the distribution of the responses.

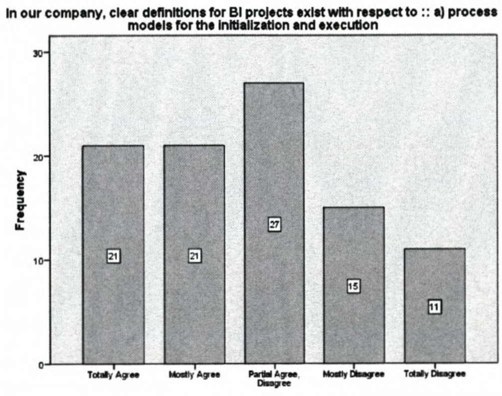
Table 6.39 - BI Architecture Documentation statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
109	4	2,88	3,0	1,19	0,03	0,23	-0,87	0,46

As many as 30.9% of the respondents disagreed that the BI architecture in their organisation was well-documented; while 37.2% of the respondents agreed that it is, with 28.3% partially agreeing/disagreeing, resulting in a neutral outcome overall. This is reinforced by a mean of 2.88, a median of 3, and a skewness index of 0.03. The lack of detailed BI systems documentation can be hazardous to the business, as knowledge of the system tends to be tacit; and there is always a danger that such knowledge could be lost. The lack of documentation could impact the value-addition of BI negatively.

Question 38 – Process Model Definitions

Question 38 represents the analysis of Process Model Definitions.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	18	15,9	15,9	15,9
Totally Agree	21	18,6	18,6	34,5
Mostly Agree	21	18,6	18,6	53,1
Partially Agree/Disagree	27	23,9	23,9	77,0
Mostly Disagree	15	13,3	13,3	90,3
Totally Disagree	11	9,7	9,7	100,0
Total	113	100,0	100,0	

Figure 6.44 - Process Model Definitions Frequencies

The respondents partially agreed/disagreed (23.9%) that clear process models for BI projects exist in their organisations. The table below shows the skewness and kurtosis, based on the distribution of the responses.

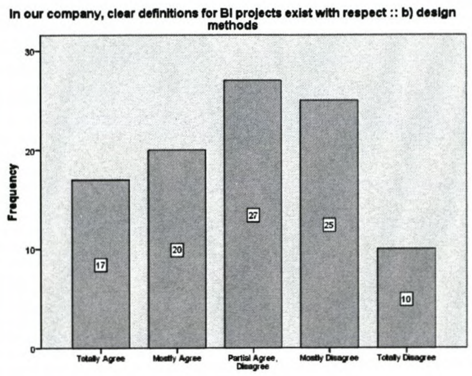
Table 6.40 - Process Model Definitions statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
95	18	2,73	3,0	1,29	0,23	0,25	-0,96	0,49

As many as 37.2% of the respondents agreed that clear definitions exist, related to process models for project initialisation and execution for BI projects within their organisation, while 23% disagreed. Therefore, there is a marginal leaning towards a positive result, seen in a mean of 2.73; while the median is 3, and a skewness index that is 0.23. A large number of respondents (18) chose not to answer this question. This could be due to a lack of process-model usage in their organisations. Clear process-model definitions may contribute positively to the value-addition of BI systems.

Question 39 – Design Methods Definitions

The diagram and tables below represent the analysis of Design Methods Definitions.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	14	12,4	12,4	12,4
Totally Agree	17	15,0	15,0	27,4
Mostly Agree	20	17,7	17,7	45,1
Partially Agree/Disagree	27	23,9	23,9	69,0
Mostly Disagree	25	22,1	22,1	91,2
Totally Disagree	10	8,8	8,8	100,0
Total	113	100,0	100,0	

Figure 6.45 - Design Methods Definitions Frequencies

The respondents partially agreed/disagreed (23.9%) that clear design methods for BI projects exist in their organisations. The table below shows the skewness and kurtosis, based on the distribution of the responses.

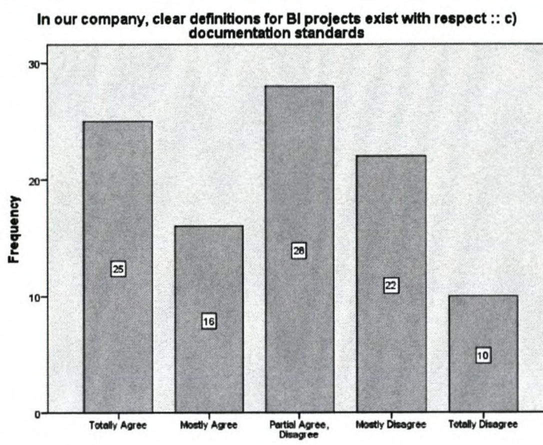
Table 6.41 - Design Methods Definitions statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
99	14	2,91	3,0	1,25	-0,05	0,24	-1,00	0,48

A total of 32.7% of the respondents agreed that there are clear definitions for design methods of BI projects in their organisations; while 30.9% disagreed, and 23.9% partially agreed/disagreed, leading to an overall neutral result. This is reinforced by a mean of 2.91, a median of 3, and a negative skewness index of -0.05. The lack of clearly defined design methods is hazardous to the organisation, as this could lead to different methods and definitions being used in BI projects, which could cause confusion within the organisation. This lack of design method definitions could contribute negatively to the value-addition of BI systems.

Question 40 – Documentation Standards Definitions

The diagram and tables below represent the analysis of Documentation Standards Definitions.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	12	10,6	10,6	10,6
Totally Agree	25	22,1	22,1	32,7
Mostly Agree	16	14,2	14,2	46,9
Partially Agree/Disagree	28	24,8	24,8	71,7
Mostly Disagree	22	19,5	19,5	91,2
Totally Disagree	10	8,8	8,8	100,0
Total	113	100,0	100,0	

Figure 6.46 - Documentation Standards Definitions Frequencies

The respondents partially agreed/disagreed (24.8%) that clear documentation of the standards for BI projects exist in their organisations. The table below shows the skewness and kurtosis, based on the distribution of the responses.

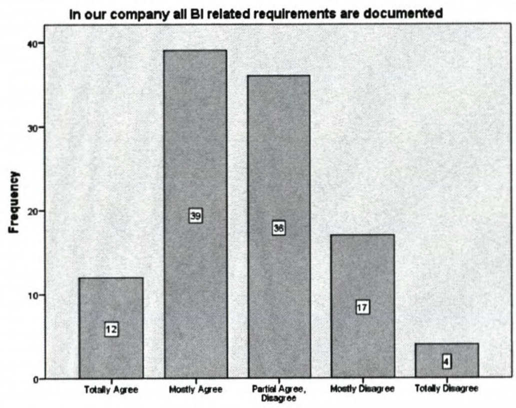
Table 6.42 - Documentation Standards Definitions statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
101	12	2,76	3,0	1,31	0,05	0,24	-1,13	0,48

As many as 36.3% of the respondents agreed that there are clear definitions for documentation standards of BI projects in their organisations; while 28.3% disagreed and 24.8% partially agreed/disagreed, leading to an overall neutral result. This is reinforced by a mean of 2.76, a median of 3, and a skewness index of 0.05. Similar to the previous question, the lack of clearly defined documentation standards for BI projects is hazardous to the organisation, as it could lead to different methods and definitions being used, which could cause confusion within the organisation. This lack of standard document definitions could therefore contribute negatively to the value-addition of BI systems.

Question 41 – BI Documentation

The information below represents the analysis of BI Documentation.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	5	4,4	4,4	4,4
Totally Agree	12	10,6	10,6	15,0
Mostly Agree	39	34,5	34,5	49,6
Partially Agree/Disagree	36	31,9	31,9	81,4
Mostly Disagree	17	15,0	15,0	96,5
Totally Disagree	4	3,5	3,5	100,0
Total	113	100,0	100,0	

Figure 6.47 - BI Documentation Frequencies

The respondents mostly agreed (34.5%) that all BI-related requirements are documented in their organisations. The table below shows the skewness and kurtosis, based on the distribution of the responses.

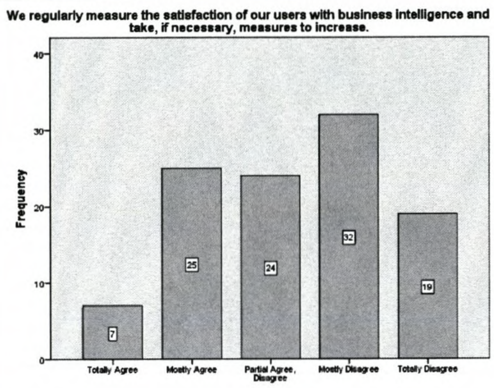
Table 6.43 - BI Documentation statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
108	5	2,65	3,0	1,00	0,30	0,23	-0,35	0,46

As many as 45.1% of the respondents agreed that the BI requirements in their organisations are clearly documented and processed; while 31.9% partially agreed/disagreed. This is reinforced by a mean of 2.65, a median of 3, and a skewness index of 0.30. The documenting of all BI-related requirements is key to the business; since knowledge of the system tends to be tacit; and there is always a danger that such knowledge could be lost. The presence of BI documentation may impact positively on the value of BI systems from a cultural and capabilities' perspective.

Question 42 – User Satisfaction

The diagram and tables below represent the analysis of User Satisfaction.



	Frequency	Percent	Valid Percent	Cumulative Percent
Don't know / Did not answer	6	5,3	5,3	5,3
Totally Agree	7	6,2	6,2	11,5
Mostly Agree	25	22,1	22,1	33,6
Partially Agree/Disagree	24	21,2	21,2	54,9
Mostly Disagree	32	28,3	28,3	83,2
Totally Disagree	19	16,8	16,8	100,0
Total	113	100,0	100,0	

Figure 6.48 - User Satisfaction Frequencies

The respondents mostly disagreed (28.3%) that BI user satisfaction is regularly measured, and that interventions are implemented where necessary in their organisations. The table below shows the skewness and kurtosis, based on the distribution of the responses.

Table 6.44 - User Satisfaction statistics

N Valid	N Missing	Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
107	6	3,29	3,0	1,20	-0,18	0,23	-0,99	0,46

Only 45.1% of the respondents disagreed that the satisfaction of BI users is regularly measured in their organisations, and that corrective steps (if necessary) are taken. This is reinforced by a mean of 3.29, a median of 3, and a negative skewness index of -0.18. The negative response points to the issue that user satisfaction is not always accurately gauged and acted on, which could lead users to not using the system. A lack of user satisfaction statistics could impact negatively on the value of BI systems from a usability perspective.

Summary

Based on the results of the empirical analysis, the following table was developed, based on each question's overall positive or negative leaning.

Table 6.45 - Question Analysis Summary

Question	Description	Response
1	Meta-models Standardisation	Negative
2	Meta-models terminology	Negative
3	Master Data Traceability	Positive
4	Master Data Versioning	Negative
5	BI Tool Compatibility	Positive
6	Uniform BI Tool Usage	Positive
7	Data Analysis Functionality	Positive
8	Forecasting Functionality	Positive
9	Scenario Modelling Functionality	Negative
10	Statistical Analysis Functionality	Positive
11	Communication and Distribution Functionality	Positive
12	Presentation and Visualisation Functionality	Positive
13	Mobility Functionality	Negative
14	Comments Functionality	Negative
15	Data Analysis Usage	Positive
16	Forecasting Usage	Positive
17	Scenario Modelling Usage	Negative
18	Statistical Analysis Usage	Positive
19	Communication and Distribution Usage	Positive
20	Presentation and Visualisation Usage	Positive
21	Mobility Usage	Negative
22	Comments Usage	Negative
23	Automated Operational Workflow Exception Reporting	Negative
24	Automated Strategic Workflow Exception Reporting	Negative
25	Data Completeness	Positive
26	Data Timeliness	Positive
27	Data Relevance	Positive
28	Data Consistency	Positive
29	Data Frequency	Negative
30	Data Integrity	Positive
31	Standard BI Architecture	Positive
32	Prescribed BI Solution Usage	Positive
33	Roles and Responsibilities	Positive
34	BI Development Regulation	Positive
35	BI Regulatory Requirements	Positive
36	User Permissions	Positive

37	BI Architecture Documentation	Positive
38	Process Model Definitions	Positive
39	Design Methods Definitions	Positive
40	Documentation Standards Definitions	Positive
41	BI Documentation	Positive
42	User Satisfaction	Negative

While some meta-model common terminology was seen to be in place, organisations appear to lack a standardised method of maintaining these; and processes need to be put in place to standardise the meta-models. Master-data were highlighted as an issue area as well, particularly from a versioning perspective. Organisations need to do more, in order to effectively manage the Master-Data as these form the basis of BI, as it impacts on data quality, most especially from a Data-Warehousing perspective, and thus on the value-addition of BI systems from an information-quality perspective.

Another area for improvement highlighted is the use of prescribed BI tools and BI tool compatibility within an organisation. This requires strict enforcement of BI Architectural standards; as this situation promotes the creation of 'Islands of Information' that are not always interoperable or efficient for organisations. The non-availability of appropriate forecasting, scenario planning, statistical analysis and descriptive comments' functionalities are also highlighted as issues. This can only be solved by ensuring that user requirements are clear, when analysing the implementation of BI system functionalities.

Another lacking functionality, which is imperative to today's business world, is the mobility of the data to be analysed and/or presented on different platforms. This is key to ensuring that users can operate anywhere, and at any time. Organisations must ensure that their BI systems' service providers can cater for this. The results could have an impact on the accessibility of BI systems and information.

From a usage perspective, forecasting, scenario-planning, presentation and visualisation, mobility and descriptive comments' functionalities are said to not be used by users. There could be a number of reasons for this. Firstly, the functionality may not be available, in which case, the organisation needs to assess whether the need for it is evident, and if so, to assess its implementation. A second scenario is that the functionality provided does not meet the user requirements. This requires a review of the functionality in question, in accordance with user requirements; and appropriate actions need to be taken. Finally, it could be that the functionality is available; but users are not using it, in which case proper training is required, which impacts on the cultural perspective of BI systems' value-addition.

Automated Operational and Strategic Workflow-Exception Reporting is not available, according to the respondents. Again, the need for this functionality must be assessed, and if found to be required, it should be implemented. From a data-perspective, the respondents identified consistency and frequency as problem areas. These can be rectified systematically by ensuring that the BI system in place tests for and enforces data consistency, as well as allowing for user scheduling of reporting, be it regular or *ad hoc*.

However, another issue identified is the lack of standard BI architecture and the lack of usage of the prescribed BI solutions within organisations. This can only be rectified by ensuring that the BI system does meet user requirements, and that the appropriate training is in place. Tied in with this, is the need for ensuring that BI documentation is up-to-date and available, as well as ensuring that BI definitions and standards are consistent across the organisation. The above impacts again on the accessibility provided by BI systems.

Finally, in order to assess the user acceptance and usage of the BI system, user satisfaction must be queried and gauged, and corrective actions taken when and where necessary. This would ensure that the users are satisfied with the functionality available from the BI system, as well as to ensure that the system is being used effectively, and impacting on the cultural impact of value-additions to the BI systems.

The results of the question analysis highlight the key areas identified in the literature review, impacting the value-addition of BI systems in the organisations queried, namely: information quality, information accessibility and an information sharing culture. With the majority of responses being positive, the results show that, while there are a number of areas for improvement, measures are on the whole in place for organisations to reap value from their BI systems.

6.4. Factor Analysis

Factor analysis is used to identify the clusters of variables that could be used to define an explanatory construct or factor (Field, 2013). In the case of this study, each variable is a specific question that was asked as part of the online survey, with a total of 42 questions being asked.

The factors are based on intrinsic value denoted by eigenvalues, some of which may exceed 1. Eigenvalues are used to explain the variances that exist between factors (Kaiser & Rice, 1974). A Kaiser-Meyer-Olkin (KMO) test was used to assess whether the variables had commonality to conduct a factor analysis. Thereafter, a Bartlett Test of Homogeneity of variances was conducted. The overall KMO value was 0,845. Kaiser and Rice (1974) specify the cut-off point value above 0.5, as being sufficient to warrant a factor analysis. The results of the Bartlett Test of Homogeneity of variances showed that all the variables are highly correlated, which allows for a factor analysis to be conducted.

Both a Varimax-rotation method and an oblique Direct-Oblimin method were tested to assess the best method for the data at hand. Ultimately, the Direct-Oblimin method was selected; as there is an expectation that there would be a form of correlation between the factors identified (Field, 2013).

The diagram below is the resultant scree plot from the data analysed.

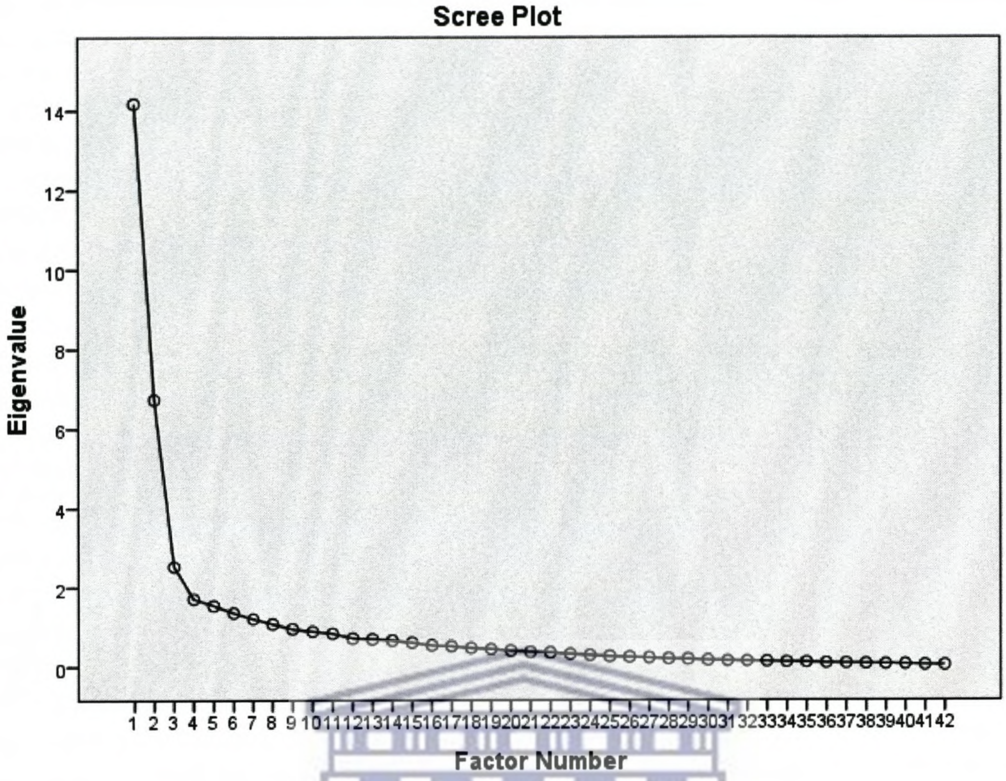


Figure 6.49 - Scree Plot

Eight factors with Eigenvalues greater than one were found, explaining 66.10% of the total variance found. However, as demonstrated in the diagram above, the first two factors explained the largest amount of variance, with the third factor only adding an additional 5% of the explained variance.

The table below presents the final Factor Matrix derived from the factor analysis.

Table 6.46 - Factor Analysis

Variables	Factors							
	Information Quality, Management and Accessibility	Information usage and culture	3	4	5	6	7	8
Our meta-models are standardized on a BI databases (even when using different databases).	0,599							
We use a common terminology in our meta-models,	0,644							
In our company, changes of BI-relevant master data (e.g. hierarchies) are traced.	0,652							
In our company versioning of BI-relevant master data occurs (e.g. hierarchies).	0,484							
All BI tools for strategic corporate management are compatible.	0,501							
The BI tools for our strategic management are used uniformly across divisions.	0,579							
In our company, BI provides the following functionalities satisfactorily:: a) data analysis	0,571							
In our company, BI provides the following functionalities satisfactorily :: b) forecasting (e.g. for future trends)			0,521					
our company, BI provides the following functionalities satisfactorily :: c) scenario modelling		0,595						
In our company, BI provides following functionalities satisfactorily :: d) statistical analysis (e.g. data mining)	0,464							

In our company, BI provides following functionalities satisfactorily:: e) communication and distribution of data	0,661							
In our company, BI provides the following functionalities satisfactorily :: f) Presentation and visualization of data in different formats and types of graphs (e.g. score-carding, dashboards)	0,645							
In our company, BI provides the following functionalities satisfactorily:: g) to present information on a variety of terminals ('Mobility')		0,725						
In our company, BI provides the following functionalities satisfactorily:: h) entering notes and descriptive comments in the system		0,665						
The users in our company actually use these functions of BI :: a) data analysis)	0,526							
The users in our company actually use these functions of BI :: b) forecasting (e.g. for future trends)			0,529					
The users in our company actually use these functions of BI :: c) scenario modelling		0,552						
The users in our company actually use these functions of BI :: d) statistical analysis (e.g. data mining)		0,440						
The users in our company actually use these functions of BI :: e) communication and distribution of data	0,522							

The users in our company actually use these functions of BI :: f) Presentation and visualization of data in different formats and types of graphs (e.g. score-carding, dashboards)	0,640							
The users in our company actually use these functions of BI :: g) to present information on a variety of terminals ('Mobility')		0,893						
The users in our company actually use these functions of BI :: h) entering notes and descriptive comments in the system		0,669						
In our company, BI provides exception reports based on automated workflows in our operational business processes.		0,726						
In our company, BI provides exception reports based on automated workflows in our strategic management processes.		0,757						
The data from our BI system are for sers ... : A) complete.	0,761							
The data from our BI system are for users ... B) timely.	0,766							
The data from our BI system are for users ... : C) are relevant.	0,755							
The data from our BI system are for users ... : D) consistent across all data sources across.	0,766							
In our company, the users define the frequency of data provision (e.g. real-time, daily, weekly).	0,417							
In our company, users can simultaneously access a variety of	0,702							

data, while data integrity is maintained.								
Our BI architecture is enterprise-wide enforced.	0,627							
In our company, the users only use the specified and implemented BI solutions.	0,576							
In our company, the operation of the BI system is based on clearly defined roles and responsibilities.	0,616							
In our company the responsibility for the (further) development of the BI system between business and IT is clearly regulated.	0,678							
In our company regulatory requirements in the operation of the BI system are taken into account (e.g. retention requirements).	0,425							
In our company, the operation of the BI system is based on clearly defined user permissions.	0,645							
In our company, the BI architecture is documented in reasonable detail.	0,699							
In our company, clear definitions for BI projects exist with respect to :: a) process models	0,699							
In our company, clear definitions for BI projects exist with respect :: b) design methods	0,677							
In our company, clear definitions for BI projects exist with respect :: c) documentation standards	0,669							
In our company all BI related requirements are documented and a processing supplied (department or project)	0,746							

We regularly measure the satisfaction of our users with BI and take, if necessary, measures to increase.		0,491						

A cut-off of 0.400 was used to assess the loading of variables onto the factors. As was seen in the Scree plot, the first two factors explained the largest amount of variance (66.1%); therefore factors three to factor eight may be ignored. Based on the loaded variables, the factors identified were grouped and tagged, such as 'Information Quality, Management and Accessibility', as the first factor; and 'Information Usage and Culture' as the second factor.

The outcomes of the factor analysis confirm the findings from the literature review, since the most prominent factors impacting the value of BI systems are information quality and information accessibility, followed by an information-sharing culture. The factor analysis also allowed for the logical grouping of information quality and accessibility; as these two factors are very closely related, and can be seen as a single over-riding factor.

6.5. Testing the propositions

Propositions generated from the literature for this research were tested, in accordance with the factors identified above. Customer satisfaction and the impact of BI systems on performance management, which were identified as factors from the literature review, are seen as external factors that cannot easily be assessed internally; but they are factors that are dependent on the remaining factors identified. The propositions, therefore, are grouped into the factor categories, specifically: Information Quality, Information Accessibility, and Culture and Capabilities.

For each proposition tested, the data are presented in a graphical format, depicting the responses on a Likert Scale ranging from "Totally Agree" to "Totally Disagree".

Based on the results of the Factor Analysis, the table below highlights the findings for the propositions.

Table 6.47 - Proposition Analysis Findings

Research Proposition	**Result**
Proposition One: Information Quality is a factor in determining the value of BI	**Valid** – respondents highlighted the value derived from the quality of information.
Proposition Two: Information Accessibility is a factor in determining the value of BI	**Valid** – respondents highlighted the value derived from the accessibility of information. Found to be combined with Proposition One.
Proposition Three: Consumer/Customer Impact is a factor in determining the value of BI	Validity could not be confirmed – Not enough information is available to directly correlate the impact of the consumer/customer to the value of BI.
Proposition Four: Information Culture is a factor in determining the value of BI	**Valid** – respondents highlighted the value derived from the existence of a culture of information management.

Proposition Five: Corporate Performance Management Impact is a factor in determining the value of BI	Validity could not be confirmed – Not enough information is available to directly correlate the impact of corporate performance management to the value of BI.

The proposition analysis showed that Information Quality has a large impact on the Value of BI, which tested positive, as did the ability to access information and the presence of a culture driven by information-sharing. Information Quality and Information Accessibility were combined into a single factor; while Information Culture remains as a separate, but correlated factor.

Proposition three and proposition five could not be proven; as no factors were found directly correlated with these propositions. It is assumed that the reason for this is that both these propositions are external propositions that are dependent on Information-Quality, Information-Accessibility and Information-Culture; and consequently, they are not direct factors related to the Value of BI.

6.6. Structural Equation Modelling

In order to assess the relationships between the factors identified in the factor analysis, a partial least squares-structural equation-modelling analysis was conducted. The value of BI systems is represented by the identified benefit that organisations see themselves achieving in the next 3 to 5 years (6.2.4).

The diagram below depicts the PLS-SEM model, derived from using the data findings of the factor analysis and the relationships between the dependent and the independent variables.

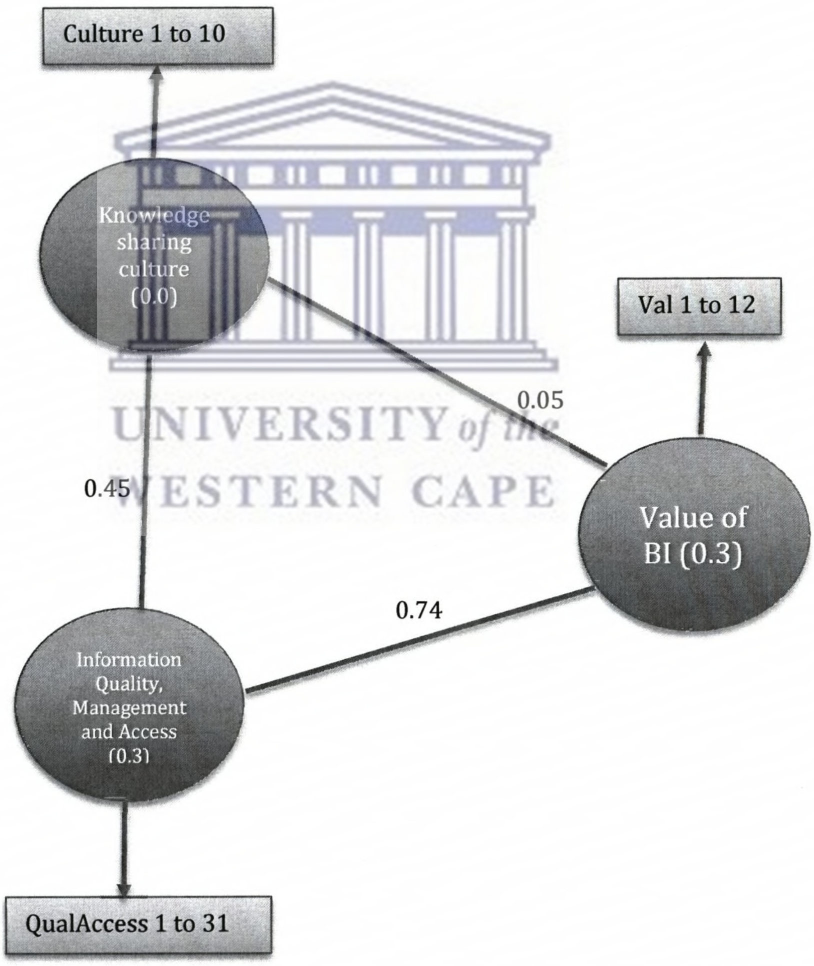


Figure 6.50 - PLS-SEM Analysis

According to the Factor-Analysis findings, the PLS-SEM model consists of three variables: the Value of BI Systems, as the dependent variable, Information-Quality, Management and Access (QualAccess) as the first independent variable, and Information-Culture (Culture), as the second independent variable. The table below highlights the loadings from the PLS-SEM analysis.

Table 6.48 - PLS-SEM Loadings

Loadings			
	Culture	QualAcess	Value of BI
Culture 1	0.822245		
Culture 2	0.805151		
Culture 3	0.690687		
Culture 4	0.808117		
Culture 5	0.645985		
Culture 6	0.785272		
Culture 7	0.749314		
Culture 8	0.831109		
Culture 9	0.841862		
Culture 10	0.773099		
QualAccess 1		0.622890	
QualAccess 2		0.652899	
QualAccess 3		0.504347	
QualAccess 4		0.483343	
QualAccess 5		0.594080	
QualAccess 6		0.620238	
QualAccess 7		0.542297	
QualAccess 8		0.480773	
QualAccess 9		0.706413	
QualAccess 10		0.640067	
QualAccess 11		0.593831	
QualAccess 12		0.506248	
QualAccess 13		0.549299	
QualAccess 14		0.619152	

QualAccess 15		0.799933	
QualAccess 16		0.827380	
QualAccess 17		0.820719	
QualAccess 18		0.813944	
QualAccess 19		0.479056	
QualAccess 20		0.766254	
QualAccess 21		0.690746	
QualAccess 22		0.671917	
QualAccess 23		0.696296	
QualAccess 24		0.748338	
QualAccess 25		0.519040	
QualAccess 26		0.734398	
QualAccess 27		0.750357	
QualAccess 28		0.749986	
QualAccess 29		0.715169	
QualAccess 30		0.697701	
QualAccess 31		0.785060	
Val1			0.855462
Val2			0.808162
Val3			0.764113
Val4			0.802790
Val5			0.854021
Val6			0.787932
Val7			0.814782
Val8			0.781085
Val9			0.759053
Val10			0.767050
Val11			0.787550
Val12			0.627196

QualAccess has 31 indicators associated with it; while Culture has 10 indicators. The Value of BI Systems (Val) indicators are derived from the 12 questions in the online survey regarding the foreseeable benefit that could be derived from BI systems in organisations. These questions measure benefit in terms of the operationalization of business strategy; the alignment of company goals across business units; the integration of strategic and operational planning; the assessment of the achievement of goals; the integration of common data; co-ordinated-management methods; the delivery of timely and relevant complete and consistent data; data robustness; transparent processes; adherence to company-wide standards; and legal-framework compliance.

The percentage variance of the Value of BI explained by the explanatory variables, specifically QualAccess and Culture, was found to be quite significant at 58.7%. Using the bootstrapping method, the t-statistical analysis found that QualAccess was significant at a 95% confidence level; while Culture was found to be closely correlated with QualAccess, while not significantly in relation to the Value of BI Systems directly. In this way, it still remains a significant variable; but more so because of its impact on QualAccess than any direct impact on the Value of BI.

The value in the circle is the R-Squared, or percentage of variance explained by the independent variables. Culture is 0 as there are no independent variables explaining it, Quality and Access has a value as a minimal amount of variance is explained by Culture, while Value of BI Systems is explained by a combination of Culture and Quality and Access and thus also has a value, greater than 0.5 implying that more than 50% of variance is explained by the two independent variables.

The factor loadings for all indicators are significant (above 0.4, according to Field (2013)). Factor loadings are higher than the factor analysis conducted earlier; as PLS-SEM uses loading estimation methods that maximise the variance explained (Hair, Hult, Ringle and Sarstedt, 2013). The standardised regression weights show the effect each independent variable has on the dependent variable. It is clear that, while both variables have a positive effect, Information Quality, Management and Access have a substantially higher effect (0.74 for QualAccess versus 0.05 for Culture); while the impact of Culture on QualAccess was 0.46, which demonstrates a significant correlation between these factors.

Based on the above findings, it can now be positively hypothesised – from a statistical perspective – that the key factors that impact the value of BI systems are a combined information quality and accessibility, and to a lesser extent, the presence of an information-sharing culture. This is significant, since it builds on the current literature by showing the combined impact of factors identified by past studies on the value of BI systems, and the relationship of each of these factors with the associated value. The value of using the PLS-SEM to identify which variables have the greatest effect on the value of BI systems from a management/executive perspective is that it clearly demonstrates that a quality perspective is the largest contributing aspect of the factors evaluated.

6.7. Conclusion

This chapter has provided the results from the empirical study conducted using the results of the online survey. The results were split into descriptive statistics of the organisations making up the sample, an analysis of each question, followed by a factor analysis, and a partial least-squares structural-equation model.

It was found that the most significant factor impacting the value of BI is that of information quality and information accessibility, followed by user usage of the functionalities made available by the system. The research propositions specified from the literature review in Chapters 2, 3 and 4 were tested statistically, and reduced to two factors using a direct Oblimin-factor analysis method, the first combining information quality, management and accessibility, and the second being information culture and usage.

Thereafter, a PLS-SEM study was conducted, which showed a strong relationship between the value of BI and the factor representing information quality/management/accessibility. While a strong impact was not found between information culture and the value of BI, a strong correlation was identified between the information quality/management/accessibility factor and the information usage and cultural factor.

Chapter 7 presents the main conclusions and recommendations, based on the findings presented in this chapter.

7. Summary, Conclusions and Recommendations

7.1. Introduction

This chapter summarises the research conducted in this thesis, highlighting the overall approach, the methodology followed and the major findings. The objectives of the research conducted will be put into perspective by means of discussions on the conclusions and the significance of the study and its implications for all key BI stakeholders. The limitations of the research will also be highlighted, together with recommendations for further studies and analyses.

7.2. Summary

As presented in this study, BI is becoming not only essential for the success of an organisation, but more and more essential for its very existence in today's business environment. Despite this, difficulty still lies in assessing the value of BI systems, making it problematic to justify any significant investments therein.

The overall research question is: "What are the factors impacting the value of BI Systems and their individual contributions? And, can their combined effect be modelled to assist in making a BI system decision, in order to enhance decision-making and add value to an organisation?" The following research sub-questions were set out at the beginning of this study:

1. *What are the main factors that contribute to the value that BI investments add to organisational growth?*
2. *How can these factors be represented in a conceptual model in order to demonstrate their value?*
3. *How applicable is this conceptual model to organisations in South Africa and Germany?*
4. *Can this model be revised based on data from South Africa and Germany?*
5. *What final combined Conceptual Model could be derived?*

The literature review addressed sub-question 1 and tracked the evolution of the concept of BI Systems, as originally merely referring to reporting systems, developing over time to decision-support systems, and finally culminating in today's understanding of BI systems to include analytical and predictive capabilities, data visualisation, and the management of big data. Supporting technology likewise evolved from basic databases, through to OLAP and data warehousing, and into BI online and BI in the cloud.

As BI systems have evolved; so too has the understanding of the value that they add to organisations. Originally assessed only in monetary terms, it was difficult to evaluate the return on investment; since most of the benefits reaped are intangible. The understanding that most BI systems value resides in indirect benefits has grown over time; and so has the need to identify and evaluate these benefits.

Based on the literature review conducted, in line with the research question, this study established five key factors impacting the value of BI from the current literature, namely: Information Quality, Information Accessibility, Impact of Consumers and Customers, Information-Sharing Culture, and finally, the Impact of BI on Corporate-Performance Management. A conceptual model based on these five factors was then proposed in line with sub-question 2. Based on the factors identified, an online survey was developed and conducted with BI and Information Technology experts across South Africa and Germany in line with sub-question 3, in order to assess their perspectives on the value of BI systems.

Using the proposed conceptual model, a Direct Oblimin-factor analysis was conducted, based on the responses gleaned from the online survey. The survey was conducted on a sample of 1500 BI specialists across South Africa and Germany, from whom 113 responses were gathered, in line with sub-question 4. The analysis conducted reduced the factors identified to two key factors, namely:

Information Quality, Management and Accessibility, as well as Information Usage and Knowledge-sharing Culture.

Thereafter, a Structural-Equation Modelling analysis was conducted, using the Partial Least-Squares method. The results indicated that a strong relationship exists between the factors of Information Quality, Management and Accessibility, and the Value of BI. It was found that while there was not a strong impact from Information Usage and Culture, there was a strong correlation between Information Usage and Culture and Information Quality, Management and Accessibility.

Finally, in line with sub-question 5, a final conceptual model representing the factors and relationships identified in the PLS-SEM analysis was developed.

7.3. Significance of Study

The research findings from this study hold significance for academic researchers, information-technology experts, BI specialists and BI users; since they present a single conceptual model highlighting the relationships between the value of BI systems and their key factors. In this way, the study contributes to the body of knowledge; since it brings together the disparate factors that have been identified in academic journals, and assesses the relationship each has on the value of BI systems, as well as the correlations that exist between these factors.

The final conceptual model derived has been tested statistically via a thorough factor analysis and a PLS-SEM analysis.

This study was conducted in both South Africa and Germany. By doing so, a larger sample was obtained: one that incorporates both a developed and a developing country's perspective on the value of BI. It has allowed for the verification of factors that make up the final conceptual model that can be applied, regardless of geographical or economic boundaries. The results could also assist organisations in assessing the impact of BI systems on their organisations more effectively, while also allowing governments and agencies alike to understand the impact of BI on the economies of their countries.

7.4. Conclusions and Implications

Based on the research study conducted, the following conclusions can be drawn: (1) the assurance of quality information in the form of complete, accurate, relevant and timeous information that is efficiently managed. This is paramount to an organisation deriving value from BI; (2) information accessibility is key, in order to accurately assess the value of BI systems. Quality data are of no value if those data cannot be accessed when required; and (3) BI cannot add value to an organisation unless a culture of information usage and sharing is being practised within that organisation.

Data and information quality have been the centre of a number of academic papers on the value-addition from BI systems; so there was no surprise when it was identified as one of the most important factors in the study conducted. A key finding was that the respondents related to the quality of information and the accessibility of the information from a technology perspective. They saw these as being the same factor. This highlights that one cannot exist without the other, specifically that good quality information is seen as inadequate, unless the appropriate technology is in place for the users to access that information – whenever needed, wherever required, and in the format that is specified.

The above finding leads to the third factor identified, which is a culture of information-sharing. This ties in very closely with the findings on information quality and accessibility. A strong relationship has been identified between these factors. This shows clearly that even if the best technology is in place, and is supporting high quality information, unless the human factor of ensuring that information sharing is practised in the organisation, the BI system would not succeed. This is a factor that is normally overlooked in most organisations; and this can be detrimental to the value that BI systems can add to an organisation.

Also, due to the strong relationship between culture and information quality and accessibility, a failure to accept a BI system in an organisation may be incorrectly attributed to the technology and data aspects – rather than addressing the cultural shortcomings. Based on these findings, the conceptual model below was derived.

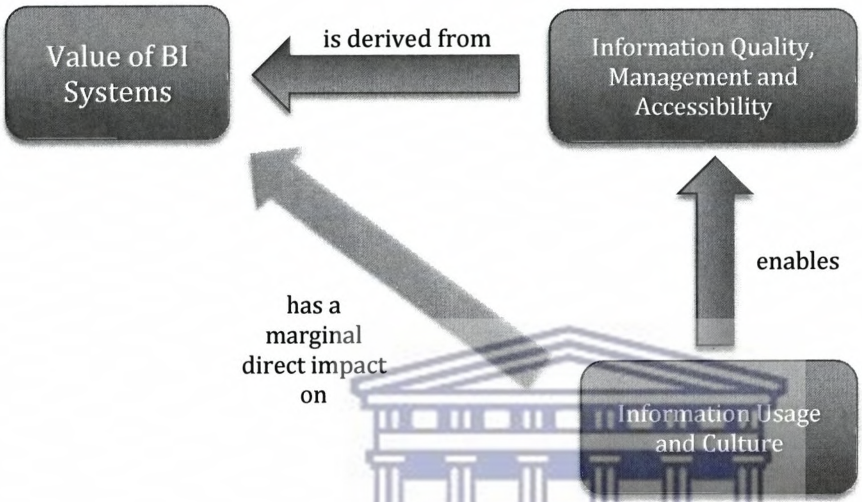


Figure 7.1 - Derived Conceptual Design

Figure 7.1 shows that information quality; management and accessibility all have the largest impact on the value of BI; while information usage and culture do not directly impact the value of BI in a large way. However, information usage and culture is strongly correlated to information quality, management and accessibility; and thus, these factors are all important within the model.

The key aspects associated with Information Quality are: completeness, accuracy, relevance, timeliness and the amount of information. In order for a BI system to add value to an organisation, its data and information must comply with all the aspects specified. If even a single aspect is not in place, users may lose trust in the BI system, which then immediately loses credibility.

Similarly, if the aspects associated with Information Management and Accessibility, namely: communication of information, compression of data and information, presentation in accordance with user requirements, secureness of sensitive information, standardised technology, automated alerts, systems integrity, BI systems roles and responsibilities, and documentation on the BI system are not in place, the users may not trust the outputs from the systems, and thus may render it dysfunctional.

In the findings on information quality and accessibility, one can immediately see that the determinant factor for the successful BI system is the human influence. This is clearly depicted in Figure 7.1 in the independent variable "Usage and Culture", which comprises knowledge levels within the organisation, interoperability across functions in the organisation, the realising of user needs and requirements, the user-controlled frequency of reporting, the system usage by users, and the accomplishing of the business functional requirements of the BI system.

The implications of this study are multi-dimensional. Firstly, from an academic perspective, this model can be used to bring together the main factors in a logical conceptual model that can be used as a benchmark for further research. Earlier research conducted looked at the individual factors and their impacts; but no study could be found that had assessed the combined impact of all the factors on the value of BI systems assessed from a statistical perspective. This study fills that gap, with the presentation of the derived conceptual model, together with the aspects of each factor. Further studies can now be conducted to assess the impact of the model in different situations and types of organisations in order to refine it specific to environment.

The model can also be made use of when assessing the viability of implementing a BI system within an organisation, as well as assessing the value-add of a current BI system that has been implemented. This assessment can take the form of a checklist that highlights each factor and its attributes and allows for the assessment of each.

From a BI vendor perspective, it creates the understanding and a measurable gauge to demonstrate that it is not enough to merely sell a BI solution; but it is necessary to ensure that all these factors have been addressed appropriately, in order to enable a successful implementation and a system that would add value. In particular, the cultural factor impacting the BI system must be taken into account in the implementation process, or the BI system may not fully achieve its true value addition in the organisation. By making use of the model, a vendor can assess their software offering from a holistic view and assess and highlight the advantages to their clients.

From an organisational perspective, it highlights the areas that must be taken into account in a measurable manner, in order to effectively see value addition of the BI system. First and foremost, information quality must be assured. However, information quality alone does not ensure value addition; and it needs to be supported by appropriate technology decisions in the organisation. Both these aspects may not achieve the true value addition possible in the organisation of the BI system – unless they also address the cultural and usage factors. These factors can only be adequately addressed via training and knowledge-sharing, amongst other interventions.

The usage and cultural factor is, therefore, key in the value addition of BI systems in an organisation; since it not only impacts value directly; but also the other factors of information quality, management and accessibility need to be addressed when assessing the value of BI systems.

7.5. Limitations and Recommendations for Future Research

Like all research studies, this study has inherent limitations, which must be highlighted. The sample used in this study was selected randomly, based on large organisations operating in South Africa and Germany. Large organisations are more likely to employ BI systems. This, however, precludes smaller organisations; and this may have led to an element of bias, based on the sample selected. Although common in many studies, the relatively small sample of respondents has also limited the ability to conduct deeper statistical analyses.

A larger and more varied sample could possibly be used, in order to further validate the derived model on a larger scale. This would allow for the generalisation of the results with greater confidence.

The external factors identified in the literature review, namely, the consumer/customer impact and corporate performance-management impact on the value of BI were not taken into account. Although they were highlighted in the academic literature review, they were found to be a consequence of the internal factors identified. It is suggested that future research be conducted to examine the impact of these and other external factors, in order to find any possible relationship that may exist between them and the value assigned to BI systems in organisations.

The conceptual model derived could be used as a basis for further research in replicating the study across different samples. This could include geographically based or industry-specific samples – to assess the value-addition of BI systems in the chosen samples. Further studies could also see the building of an economic model that could be used by organisations, in order to further quantify the factors identified in monetary terms, and thus further enhance financial decisions on the investment in BI systems.

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APPENDICES

Appendix A: Publications from thesis

Publications
"Towards a Conceptual Model to assess the factors impacting the non-financial value of Business Intelligence" presented at the International conference on Computer Science and Information Systems (ICSIS'2014). Article published in conference proceedings.
"An analysis of Business Intelligence requirements in South African corporates" accepted for presentation and publication at ICBISE 2015: International Conference on Business Intelligence and Systems Engineering to be held on Jul 04-05, 2015 in Singapore, SG.

Appendix B: Survey Cover Letter

Dear Sir/Madam,

The University of Western Cape in South Africa and the Neu-Ulm University of Applied Sciences are running a research project on the topic: "Business value of BI Systems (BI Systems)". The aim of this research project is to analyse whether and how far BI could enhance the success of business organisations related to the planning, monitoring and control of strategic and operational business activities.

The project results should present the correlation between BI-investment and the success of organisations.

On the basis of these results, organisations should be able to evaluate the level of their own BI-activities, on the basis of which they could define a customised BI-Strategy.

The following questionnaire presents a comprehensive and extensive review of the current appraisal of BI.

We consider **BI** as: *"An umbrella term that spans the people, processes and applications tools to organize information, enables access to it and analyses it to improve decisions and manage performance"*. (Source: Gartner Group)
We thank you in advance for your answer; and we appreciate the time and the great interest you have shown in our project.

We would like to emphasise that your information is used only for research purposes, and will be handled with great care.

Appendix C: Reminder Email

Dear Participant,

On 2 April 2013, we sent out an email from BIValue@UWC.AC.ZA, requesting participation in an international research project undertaken by The University of Western Cape in South Africa and the Neu-Ulm University of Applied Sciences in Germany, in order to establish the true value of BI.

A number of you have completed the questionnaire; and we thank you for your effort. The results will be shared with all research participants in the form of a formal research report.

A number of you have started the questionnaire, but did not complete it. We truly appreciate the time you took out of you very busy schedule to start this process. In order to get full value of the research, would it be possible to please complete the process.

If you did not receive our previous email, or did not have a chance to complete the questionnaire, we would highly appreciate your input at the following link: **https://businessvalueofbusinessintelligence.evalandgo.com/s/?id=JTlDcSU5OWs=&a=JTlDayU5Mmw**

The University of Western Cape in South Africa and the Neu-Ulm University of Applied Sciences in Germany are running a project research on the topic 'Business value of BI (BI)'. The aim of this project research is to analyse whether and how far BI could enhance the success of business organizations related to the planning, monitoring and control of strategic and operational business activities.

The project results should present the correlation between BI-investment and the success of organizations.

Organizations should be able to evaluate the level of their own BI-activities, on the basis of which they could define a customized BI-Strategy.

The questionnaire presents a comprehensive and extensive review of the current appraisal of Corporate-Performance Management and BI.

We consider Corporate-Performance Management as "a methodology to optimize the execution of business strategy that consists of a set of integrated, closed-loop management and analytic processes, supported by technology, that address financial, as well as operational activities, or data. It is an enabler for business in defining strategic goals, and then measuring and managing performance against those strategic goals.

The core financial and operational processes of CPM include planning, consolidation and reporting, modelling, analysis, and the monitoring of key performance indicators (KPIs) linked to organizational strategy". (Source: Business Performance Management Standard Group, 2005)

We consider BI as "an umbrella term that spans the people, processes and application tools to organize information, enable access to it, and analyze it, [in order] to improve decisions and manage performance" (Source: Gartner Group).

We thank you in advance for your answer and appreciate the time and the great interest you have shown in our project.

We would like to emphasize that your information is used only for research purposes, and will be handled with great care.

Upon completion of the project, we will furnish all project participants with a copy of the project report, detailing our findings, conclusions and recommendations.

Please follow the link below to participate in this research:

https://businessvalueofbusinessintelligence.evalandgo.com/s/?id=JTlDcSU5OWs=&a=JTlDayU5Mmw

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Appendix D: Survey

General questions

1. Total annual turnover	< 250 Mio ZAR 250 - 500 Mio ZAR 501 - 1.250 Mio ZAR 1.251 - 2.500 Mio ZAR 2.501 - 5.000 Mio ZAR > 5.000 Mio ZAR
2. Sales turnover of the last 3 years	- declining (< -2%) - continuous (-2% - +2%) - increasing (> +2%) - No answer
3. Earnings performance of the last 3 years	- declining (< -2%) - continuous (-2% - +2%) - increasing (> +2%) - No answer
4. Employee fulltime equivalence	< 250 251 - 500 501 - 1.000 1.001 - 5.000 5.001 - 10.000 > 10.000
5. Years of trading period	0 to 5 / 6 to 10 / 11 to 15 / 16 to 20 / 20 +
6. Industry type	- Mining and quarrying industries - Manufacturing of food and forage - Manufacturing of wearing apparel - Manufacturing of leather, leather-related products and shoes - Manufacturing of printing products - Manufacturing of chemical products - Manufacturing of pharmaceutical products - Manufacturing of rubber products and plastic products - Metal production and processing - Manufacturing of metal products - Manufacturing of electrical equipment - Mechanic engineering - Manufacturing of furniture - Manufacturing of miscellaneous products - Energy supply - Construction industry - Miscellaneous

7. Job title of the respondent	- Managing director/CEO, - Business director, - Technical director, - Finance & Accountancy/CFO, - CIO, - Staff function, - Miscellaneous
8. Legal form of the company	- private limited company - public limited company - Miscellaneous
9. Does your company belong to a company group?	yes/no If "no", please go forward with question 13 If "yes", go forward with question 10
10. How many companies belong to this alliance?	Open question
11. Are the companies of the alliance independent legal entities?	yes/no
12. Do you have a uniform management of IT?	yes/no
13. Is the IT architecture determined company-internal or cross-company?	- Company-internal - Cross-company
14. Is your BI architecture based on an integrated platform of a **single** provider?	yes/no If "no", please go forward with question 16 If "yes", go forward with question 15
15. Do you use ERP software and BI systems of the same provider?	yes / no
16. Which BI system**s** does your company use? (name of providers)	- - - - -
17. How much did your company spent on BI over the last five years?	In ZAR
18. Please indicate the percentage spent on BI in the following categories:	Software Hardware Detailed report development Management and strategic dashboards

Please evaluate the following statements for your company with regard to your **current status.**

1. In our organisation the meta-models in all BI databases are **standardised** (even if there are a variety of database formats.)	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
2. In our organisation the meta-models use the same **standardised terminology**.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
3. In our organisation the BI-Tools used for corporate performance management processes are **interoperable**.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
4. In our organisation the BI-Tools used for corporate performance management processes are the same **for each functional area**.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
5. In our organisation data changes of BI relevant master data (e.g. hierarchies) can be traced	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
6. In our organisation versioning control of BI relevant master data (e.g. hierarchies) is practiced.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
7. In our organisation BI provides a sufficient feature set for **data analysis** (e.g. to show past trends).	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
8. This feature set for **data analysis** (if available) is used by our users.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know

9.	In our organisation BI provides a sufficient feature set for **predictive forecasting** (e.g. to show future trends).	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
10.	This feature set for **predictive forecasting** (if available) is used by our users.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
11.	In our organisation BI provides a sufficient feature set for **scenario modelling**.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
12.	This feature set for **scenario modelling** (if available) is used by our users.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
13.	In our organisation BI provides a sufficient feature set for **statistical analysis** (e.g. data mining).	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
14.	This feature set for **statistical analysis** (if available) is used by our users.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
15.	In our organisation BI provides a sufficient feature set to **share** and **disseminate** data.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
16.	This feature set to **share** and **disseminate** data (if available) is used by our users.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
17.	In our organisation BI provides	Totally agree / mostly agree / partially

a sufficient feature set to **present and visualize data in different formats and graphics** (e.g. score-carding and dash-boarding).	agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
18. This feature set to **present and visualize data in different formats and graphics** (if available) is used by our users.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
19. In our organisation BI provides a sufficient feature set to present data/information on **several devices** („mobility").	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
20. This feature set to set to present data/information on **several devices** („mobility") is used by our users.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
21. In our organisation BI provides a sufficient feature set for the users to add describing **comments / notes** to the system.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
22. In our organisation we use BI **comments / notes**.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
23. In our organisation BI provides a sufficient feature set for alerts linked to the automated workflow data in our **operational business processes.**	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
24. In our organisation BI provides a sufficient feature set for alerts linked to the automated workflow data in our **strategic business processes.**	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know

25.	In our organisation BI components supply **complete** data according to the needs of the users.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
26.	In our organisation BI components supply **current** data according to the needs of the users.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
27.	In our organisation the **frequency** of data supply is determined by the user (e.g. real-time, daily, weekly…)	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
28.	In our organisation BI components supply **relevant data** according to the needs of the users.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
29.	In our organisation we have **consistent** data across the databases	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
30.	In our organisation users have **simultaneous** access to data while maintaining data integrity.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
31.	In our organisation the BI-Architecture which defines the existing BI components is **binding** throughout the whole enterprise.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
32.	In our organisation users use **only** the implemented BI-solutions.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know

33. In our organisation the **operation** of the BI system is based on clearly defined roles and responsibilities.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
34. In our organisation the **enhancement** of the BI system is based on clearly defined roles and responsibilities between our functional and IT departments.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
35. In our organisation we consider **regulatory requirements** by operating our BI system (if available), e.g. legal obligations to keep data.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
36. In our organisation the operation of the BI system is in compliance with **clearly defined user rights**.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
37. In our organisation the BI architecture is described in an appropriately **detailed document**.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
38. In our organisation there are clearly defined **procedure models** for planning and implementing BI projects.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
39. In our organisation there are clearly defined **design methods** for BI projects.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
40. In our organisation there are clearly defined **documentation standards** for BI projects.	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
41. In our organisation all new	Totally agree / mostly agree / partially

	requirements of BI are documented and evaluated by functional departments or project team.	agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know
42.	In our organisation we take action to increase user BI satisfaction based on regular measurement	Totally agree / mostly agree / partially agree/disagree / mostly disagree / totally disagree/ statement not relevant/I do not know

Summary Validation:		
43.	Please choose which of the following attributes are suitable to generate the greatest business value of BI in your company: a) Operationalisation of business strategy b) Alignment of business units towards corporate and business objectives c) Linkage between strategic and operational planning d) Feedback loop to control the attainment of objectives and deduction of measures if objectives are missed e) Integration through common data and aligned management methods f) Supply the management with current data g) Ensure robust and non-arbitrarily data supply process for the management h) Supply the management with relevant, complete and consistent data i) Transparent and communicated corporate performance processes j) Enterprise-wide standards and tools for corporate performance management k) Compliance with external	<u>Expected value in 3-5 years:</u> Low value / marginal value / average value, rather high value / high value / statement not relevant / I do not know

legal regulations	

If you would like to be informed about the results of the survey, please fill in your email address below. ____________________________________