Towards a better understanding of the influence of Business Intelligence (BI) Maturity Level on the relationship between BI Success and the BI Capabilities, with a focus on Data Quality as a BI Capability.

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Dissertation submitted in part fulfilment of the requirements for the degree of Master of Science in Management at National College of Ireland

Submitted to the National College of Ireland, August 2019

Abstract

Title: Towards a better understanding of the influence of Business Intelligence (BI) Maturity Level on the relationship between BI Success and the BI Capabilities, with a focus on Data Quality as a BI Capability.

Name: David Lafferty

Purpose: The purpose of this study is to extend the research carried out in previous research related to BI system Success factors to examine the relationship between BI Success and BI Data Quality capabilities using a quantitative approach. This dissertation also examines how the BI Maturity Level of an organisation can influence the strength of the relationship between BI Success and BI Data Quality capabilities

Structure: This study adopted a quantitative approach to research. Respondents were questioned through an online, open and closed question survey to gather data regarding their satisfaction with their BI system, the strengths of the BI Quality capabilities and questions designed to enable calculation of their organisations BI Maturity Level.

Originality/Value: It is becoming ever more important for Business to make best use of the vast amount of data that is being created within organisations to support their decision-making processes. As data becomes ever more complex, the need to have a BI system does supports this becomes ever more important. Despite the importance of BI Systems for business there is still a very high failure rate of BI implementation and adoption. There is currently not enough research in the area of BI success for a framework to be established to guide organisations towards BI system implementation.

Concluding Statement: Results validate previous research results that show the strong correlation between BI Success and BI quality Capabilities. Results indicate that organisations with Lower Maturity Levels have less reliance on Data Reliability and Data Source Quality then those with higher Maturity Levels, but that Data Quality is very important regardless of Level.

Keywords: BI Success; BI Quality Capability; BI Maturity Model; Business Intelligence;

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Degree for which thesis is submitted: MSc in Management

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1. Chapter 1: Overview

1.1. Introduction

Business Intelligence (BI) System is an umbrella term used to refer to a wide range of technologies and applications used for analysis of data to enable organisations to improve and facilitate well-informed decision-making (Yeoh & Popovic, 2016; Farzaneh, et al., 2018; Audzeyeva & Hudson, 2016).

For Business to succeed it is important for them to take advantage of information available to them, but this is becoming more and more difficult as the volume and complexity of data is ever increasing (Schick, et al., 2011). BI Systems are seen as a way to facilitate faster access to accurate data, which supports faster and improved decision making, improved business processes and enhanced capabilities for businesses to adapt in changing environments (Olszak, 2016). Business Intelligence and the related field of big data is also becoming increase more important in the academic and business groups (Chen, et al., 2012). A rapidly growing number of organisation view BI not as a nice to have but rather a necessity for their competitive survival (Watson, 2010).

BI is consistently a key topic for Chief Executives in the context of strategic planning (Yeoh & Popovic, 2016). Yet despite the importance given to it by organisations, the failure rates for BI implementation and its underutilization are extremely high (Garcíaa & Pinzóna, 2017).

BI has a fast growing market (Salmasi, et al., 2016), but the critical success factors of BI implementation are still poorly understood (Yeoh & Popovic, 2016). BI has emerged as a vital area of study (Batra, 2018).

Closely related to BI success is the concept of an organisations BI Maturity Level. The Maturity Models help organisations assess the

influence or impact of Bi Systems within their decision making processes (Rajterič, 2010).

It is important for organisations to understand their Maturity Level so that they can effectively plan and develop strategies to increase their Maturity Levels and bring additional value to their business from the BI Systems (Raber, et al., 2012).

This dissertation seeks to further the understanding of successfully Implementing and Adoption BI within an organisation and the key BI capabilities that support it. This dissertation will focus on data quality which is considered a key Capability for BI Success (Mudzana & Maharaj, 2017) and look at its relationship to BI Success through a quantitative survey targeted at BI Users or professionals. This survey was adapted from previous research into measuring BI success and BI Capabilities by Isik, et al. (2012).

As organisations are at various levels of BI Maturity, this dissertation will also look to measure the BI Maturity Level of the survey participants organisations and examine how the Maturity Level influences the relationship between BI success and BI Quality Capability.

The measurement of the BI Maturity Levels by be carried out based on the work by Raber, et al. (2013) who developed on instrument to measure BI Maturity Levels based on BI Capabilities and usage of BI Systems within the Organisations.

This dissertation research Quantitative methodological approach follows previous studies in this area which attempted to measure relationships between BI success factors, BI capabilities and the BI Success within an organisation (Popovič, et al., 2012; Isik, et al., 2012; Fink, et al., 2017; Salmasi, et al., 2016).

1.2. Justification for Research

Business Intelligence continues to be a top priority for senior executives in many different organisations across all industries (Isik, et al., 2013). As critical as BI Systems are to many organisations there are still very high failure rates for their successful adoption and implementation (Garcíaa & Pinzóna, 2017).

In today's competitive environment there is a requirement for companies to be able to make more informed decision at a quicker speed and companies are becoming more reliant on using BI to facilitate this requirement to stay competitive (Foster, et al., 2015).

Despite this large Business need to implement these BI systems, there is a recognition within previous studies that there needs to be more research in this field and that due to this lack of empirical data on BI Success and capabilities there is not enough evidence to create a framework or guide for organisations to follow so that they successful implement and expand their BI to meet their needs (Ramakrishnan, et al., 2012).

Continual improvement of an organisations BI system and support structures are critical to remain competitive and increase competitiveness. This Continual improvement requires an organisation to understand its strengths and weaknesses in its BI capabilities (Becker, et al., 2009). This understanding is developed from an assessment of its core capabilities is captured in the concept of its BI Maturity Level (Raber, et al., 2012).

This dissertation looks to further the research in the area of BI Maturity Models and in particular linking an organisations Maturity Model to the organisation's BI quality capability. The future goal is that organisations will be able to confidently self-assess their own Maturity level and drawing on an understanding of the relationship between BI Success and BI capabilities for their current Maturity Level and the Level

they wish is get to, a framework and guide will be available to them to build a successful strategy to achieve their BI goals.

1.3. Research Aims and Objectives

The primary aim of this research is to further the understanding of the relationship between BI Success and BI Quality Capability. The aim is to achieve this by empirically calculating the strength of the relationship between three aspects of BI Quality, which are Data Quality, Data Reliability and Data Source Quality.

The objective is that this measurement will further the understanding of the important of strengthening Quality capability when organisations embark on BI System implementation or increasing BI Adoption.

The secondary aim is to examines through empirical measurement the influence of an Organisations BI Maturity Level on the relationship between BI Quality and BI Success.

The objective of this is so that organisations can understand the relative importance of BI Quality capabilities and therefore gain more insight into BI strategy development for their organisations.

A third aim is to showcase the instrument developed by Raber, et al. (2013) to assess the Maturity Level of an organisation. Maturity Model assessment as been operationalised into a questionnaire survey which will provide organisations an easy way to self-assess their maturity levels. The Author believes this could become a vital tool in the future for organisations who wish to develop their BI usage.

1.4. Research Question

The Research question is to examine the relationship between BI Capabilities and BI Success and the influence that the organisations BI Maturity has on that relationship.

In particular the BI capability of Quality. Quality was selected as it is consistent in its important for BI Success for all Maturity Levels, and it is a key success factor in for BI implementation and usage and hence understanding this relationship has key value in the area of furthering BI research and understanding of BI in organisations.

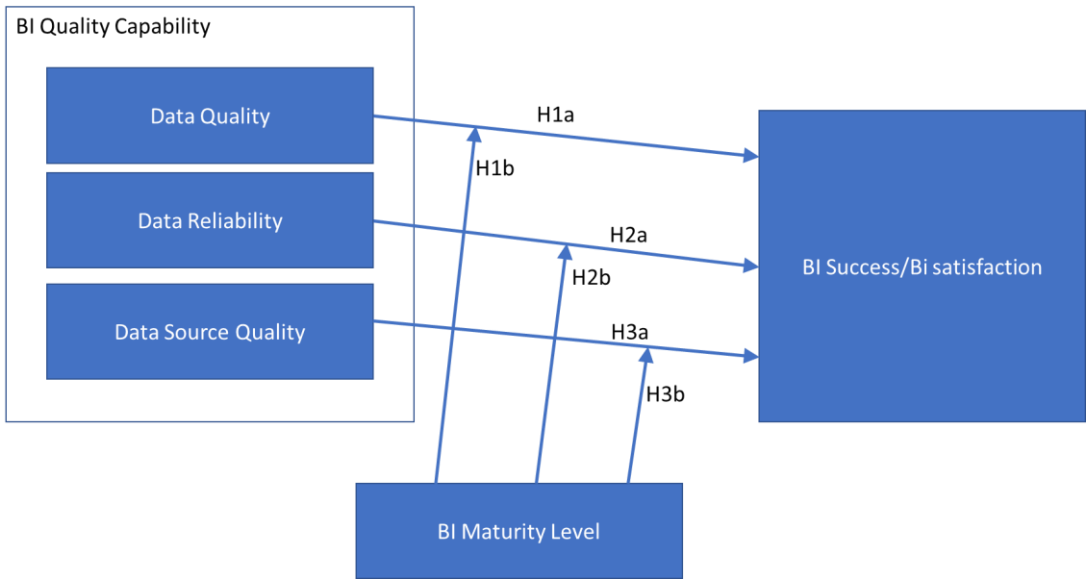

Figure 1 – Research Model

The Hypothesis being examined are illustrated in Fig 1. They are

H1a: Data Quality has a positive relationship with BI Success,

H1b: The relationship between Data Quality and BI Success is positively influenced by Level of BI Maturity

H2a: Data Reliability has a positive relationship with BI Success,

H2b: The relationship between Data Reliability and BI Success is positively influenced by Level of BI Maturity

H3a: Data Source Quality has a positive relationship with BI Success,

H3b: The relationship between Data Source Quality and BI Success is positively influenced by Level of BI Maturity

1.5. Scope and Limitations

The scope of this dissertation is examining the strength of the relationship between BI Quality Capability and BI Satisfaction and determine whether an organisations BI Maturity Level has an influence on the relationship.

To achieve this the study will also to assessing the BI Maturity Level of the organisations participating in the study.

The Study will only in examining BI Quality Capability which will be split into three separate quality types, data Quality, Data Reliability and Data Source Quality. It will not be looking at other BI Capabilities but expanding this research into other Bi capabilities is a suggestion for future research.

The research will not be using Qualitative Studies to illicit deeper understanding of BI issues, it is using research questions to test hypothesis of the relationships between success and Quality and the influence Maturity levels have on it.

The research will not attempt to validate the operationalisation of the BI Maturity Model developed by Raber, et al. (2013). It is assuming this to be validate, but further research should be carried out to validate the instrument used.

There are many streams of BI research that look at how Business create value from BI (Trieu, 2017) but this research will not be looking at this area of BI research.

1.6. Dissertation Structure

This dissertation will follow the following structure. Chapter 2 will contain a review of relevant literature related to BI success, Capabilities and BI Maturity Models and revisit the importance of BI to organisations in today's world. Chapter 3 Will describe the Research Methodology and methods used in the research. Chapter 4 will present the analysis and finds of the research. Chapter 5 will contain a discussion on the findings Chapter 6 will outline the conclusion of the works and present practical business implications and recommendations for Future research.

2. Literature Review

2.1. Academic definitions and understanding of Business Intelligence (BI) Systems

Business Intelligence (BI) Systems is an umbrella term used to refer to a wide range of technologies and applications used for analysis of data to enable organisations to improve and facilitate well-informed decision-making (Audzeyeva & Hudson, 2016; Farzaneh, et al., 2018; Yeoh & Popovic, 2016)

There is no academically accepted one definitions of BI (Isik, et al., 2012) and so is in part due to the changing view of BI over time and also the differing views of what business value organisations expect BI to deliver. The changing views can be seen in the context of developing technologies that can change the BI offerings to the Business (Rajterič, 2010). Organisations expectations can also change based on the BI Maturity and the capabilities of the Organisation. This aspect will be covered in later sections in the paper.

Over time, the role of BI has changed from a technical application view to an organisational capability that has strategic importance, where

questions of organizational capability and business alignment are as important, if not more important than technical capability (Raber, et al., 2013).

Despite these differing definitions and expectations of what BI is and how it should add value to the businesses, there are still some accepted broad definitions of what the purpose of BI is, and the capabilities required to successful implement it.

The term BI was coined by Gartner in the 1990s and its purpose grew from a need for Organisations to be able to analyse their growing about of data and help provide a platform to aid decision making in the business.

Some define BI from a holistic and sophisticated decision support system across the functions of an organisation, others take a view of BI from a technical point of view, but a commonly accepted view is that BI is comprised of both technical and organisational elements that enable users to make decisions based on data (Isik, et al., 2012).

The general purpose of BI is to help organizations organise and structure their internal and external data sources to facilitate the analysis to the data to add value to the data driven decision making processes within the organisation (Popovič, et al., 2012). Dependent of the BI Maturity of the organisation, this could involve automated operational reports based on internal data or complicated dynamically generated forecasting tools driven from data derived from multiple internal and external systems.

In any form of BI, BI is established within an organization add value to an organisation by increasing the organisations performance by enabling better decision-making processes and support of management (Isik, et al., 2012).

At a Mature BI level, we understand BI as the ability of an organisation or to reason, forecast, identify and help problems, analyse in abstract and flexible manner, comprehend and innovate in ways that increase

organizational knowledge, inform and support decision processes and actions, and help to progress business strategies and achieve business goals (Popovič, et al., 2012). It is critical that organisations can evaluate their current BI systems so that they can make improvements and ensure continuous evolution (Brichni, et al., 2017).

BI consist of a series of systems and tools that provide technological capabilities that integrate systems and provide reliable and quality data organisational capabilities that support the effective use and consumption of the data with the organisation.

2.2. Importance of understanding BI System success

BI consistently ranks in the top two agenda items of senior executives (Isik, et al., 2013). A consistent theme within the articles researched is the argument that BI is of critical importance for the survival for businesses in the modern world (Garcíaa & Pinzóna, 2017). The reason for this requirement is the demand for senior Management to be able to make decisions quickly and on the basis of accurate and timely data. A Successful BI system should deliver this (Garcíaa & Pinzóna, 2017). As businesses face a variety of unforeseen events that can impact on their performance and competitiveness, BI is seen as solution to help identify events and help mitigate them (Fourati-Jamoussi & Niamba, 2016). BI Systems can be used to enhance its decision-making processes (Gauzelina & Bentza, 2017).

While Successful BI is critical for delivering timely and insightful information, failures in a BI system will have negative impacts in the organisation in relation to wasted resources (Garcíaa & Pinzóna, 2017).

Successful BI can also provide Organisations an opportunity to gain a competitive advantage if utilized correctly (Mudzana & Maharaj, 2017; Salmasi, et al., 2016; Ghazanfari, et al., 2011). In environments which are constantly changing, it is crucial for dynamic businesses to have BI

Success to improve decision making on resource allocation (Salmasi, et al., 2016).

Another important need for Successful BI is that within complex Businesses there is increasing demand for inter functional data flow to enable discrete functions facilitate strategic cross functional decisions and planning (Farzaneh, et al., 2018). Rapidly changing Business environments demands an agility from companies to respond quickly, and BI has an important role in enhancing this agility (Isik, et al., 2013). BI Systems are now being increasing used in areas that involve making decisions with the purpose to create value from the Business (Trieu, 2017).

It is established that BI System success is important, but another consistent message across all the literature is in reference that how often BI implementation ends in failure. Failures rates are referenced as high as 80% (Garcíaa & Pinzóna, 2017; Salmasi, et al., 2016). The high failure rates indicate a need for further research, but the variety of potential reasons for that failure and the myriad of key success factors required to increase the chances of a successful implementation open a number of areas for potential research.

Another consistent issue highlighted by the literature is the statement that very few research studies have been conducted to supplement the areas identified as being key success factors for successful implementation (Yeoh & Popovic, 2016). Although there are very high failure rates, few studies have looked into the success factors of BI systems (Mudzana & Maharaj, 2017). BI capabilities have not been widely examined in an academic sense (Isik, et al., 2012). Despite the acceptance that BI is important to the performance of organisations, it is suggested, that the benefits of BI has not been adequately researched (Popovič, et al., 2012).

The reasons for the High failure rates are not clear, and further research on this topic is vital for organisations (Olszak, 2016). It is stated that some organisations fail in their BI approach and one of the

reasons is a lack BI guidelines and best practices in how to develop and use a BI system in order to gain benefits within the organisation (Olszak, 2016).

BI has a fast growing market. This in itself is a reason to highlight BI Success as an important topic for further research (Farzaneh, et al., 2018). There is also a lack of established and imperially proven scientific studies evaluating the successful implementation and utilization of BI systems (Farzaneh, et al., 2018).

It is noted that the Role-based View, Critical Success Factors and theory of Maturity Models could provide a foundation to develop guidance for organisations (Olszak, 2016).

It has been argued that when Organisations make BI system implementation and adoption decisions without clearly understanding the critical BI capabilities that are integral to the BI System success, then the chances of BI adoption failure become much higher (Isik, et al., 2012).

2.3. Defining BI Success for an Organisation

Defining BI Success can be a challenge as each organisation may have different success criteria for their implemented BI systems and may have introduced BI for very reasons.

To determine whether a BI system has been success you must look at what the intended output of the BI system was.

BI Success may represent tangible return on investment criteria like improved process efficiencies, reduction of operational costs, increase in profit. Measuring these success outcomes can be challenging.

Other companies measure the success of BI based on intangible factors like perception of users and the how the organisation perceive the

important of BI with the context of the organisation's overall strategy and success.

Apart from measuring the intangible and tangible success factors, the other important aspect of BI success is the expectation of the Business and users of what a successful BI system should bring to the organisation. In this context the expectation can be argued to be linked to the BI maturity of the organisation, which can to related to the level of invest the organisation puts into the BI system. In simple terms if an organisation and its BI users only expect static operational reports from individual data systems then success can be achieved from a relatively simple BI system without much need for high quality and advanced BI capabilities in the organisation. For organisations expecting integrated BI system with high levels of flexibility and data quality, with BI capabilities for large numbers of business users to perform advanced analytics to help make decisions in an unstructured decision environment, to attain BI success would be at a much higher bar (Isik, et al., 2013).

From a practical viewpoint how satisfied a user is with the BI system add its various capabilities is often used as a proxy for how success the BI system is (Isik, et al., 2012).

Most important factors in BI success relate to the Skills and Capabilities of the Users and Management and the Culture of the organisation rather than Technology and infrastructure challenges, although Technology and infrastructure are still important factors (Olszak, 2016).

Looking at Critical Success Factors it was shown that 19 identified factors were all important in the context of BI success (Salmasi, et al., 2016).

2.4. Overview of BI Capabilities

BI Capabilities are critical functions that are required in the successful adoption of BI systems. These Capabilities facilitate the adoption in terms of organisational change and performance of the BI System (Isik, et al., 2013).

BI Capabilities can be examined under the two categories of technological and organisational capabilities.

Technological capabilities are related to the implementation of technical platforms, systems and databases that ideally have a structured technological architecture and defined data quality standards and controls (Isik, et al., 2013).

Organisational capabilities are competences and structures that support the usage and adaptation of the BI systems within the organisation, such as flexibility and shared risks and ownership.

BI capabilities can be broken down into sub components but the author will describe the BI capabilities under 5 key categories, Data Quality, Integration with other Systems, User Access, Flexibility, Risk management Support.

As Organisation BI Maturity increases there is a demand to transition from a BI system primary used for structured decision based on internal quantitative data to a BI System that can support more unstructured decisions based on multiple systems with combinations of qualitative and quantities data that is integrated into single data warehouses. The ability to make this transition is dependent on the level of BI capabilities within the organisations (Isik, et al., 2013).

2.4.1. Data Quality

Data Quality refers to the consistency and comprehensiveness of data within a Bi System. It has been estimated that more of half of BI Systems fail because of Poor Data Quality issues.

According to Gartner research organisations believe that poor data quality costs an average of $15 million per year in losses.

There are a number of dimensions related to data quality in the context of BI capabilities. These include Accuracy, Completeness, Consistency, Conformity, Uniqueness, Integrity, Timeliness.

Data can be internal or external data. Internal data sources are generally better managed and maintained by organisations and these would be the primary data sources for traditional Bi Systems. As Organisation Maturity Levels increase it can be argued that there is a greater need for incorporating external data sources into the BI Systems as Strategic Business decisions are made based on data organised and analysed within BI systems. These external data sources can make the data quality control more complicated as the organisation does not have full control of data type and content.

For decisions to be made based from Data outputs on a BI systems it is critical that the data is accurate and reliable (Isik, et al., 2012).

It has been argued by research that the better the data quality in an organisation, the greater the BI success (Isik, et al., 2013).

2.4.2. Integration with other systems

Integration between systems is a critical factor in the success in BI systems. This integration provides an further value on the data as it connects data from multiple systems in a meaningful way.

As the variety of different data sources that are key to the operation of Organisations increase, the importance of system integration for a BI system also increases (Isik, et al., 2013).

It is argued that the higher the quality of integration of BI with other systems in an organization, the greater the BI success (Isik, et al., 2013).

2.4.3. User access

Organisations use BI systems for different purposes and in different ways dependent on the role of the BI system consumers. A user may need to run operational reports that are formally structured and performed in a scheduled manner and in a controlled environment, and other users may require ad hoc unstructured information from different locations and times. The requirements from these users in the context of access would be very different, and as such their perception of acceptable levels of user access could be very different. A satisfactory level of User access is the access that allows a user to use the system in a manner that enables them to make the decisions they require to make for their role.

One size does not fit all within BI systems and organisations need to use different systems for implementing BI systems depending on how users need to interact and use the BI system. Matching the BI system capabilities with the user type is considered to be a good strategy (Isik, et al., 2012).

Providing the right level is access requires the technical tools to implement system access controls, but also the organisational structure and governance controls to facilitate the authorisation of the correct levels.

2.4.4. Flexibility

Flexibility refers to the capability of BI to provide methods to analysis data is various ways and from various sources to facilitate the decision making process. In a practical sense it allows users freedom to control input data, parameters, data sources in a configurable way when analysing data. This flexibility is required to support the decision making processes in organisations that have variations within their

business processes and IT Infrastructure and systems (Gebauer & Schober, 2006).

The degree of flexibility in a BI system is an important factor in the usage and success of the system. If the system is too flexibility this can lead to increased complexity for the users and they will need to have a higher level of understanding of the IT data sources and data relationships. Is there is too little flexibility the system many not be able to analysis the data in a way that is required to assist the user in their decision making process (Gebauer & Schober, 2006; Isik, et al., 2012).

It can be argued that the higher BI Maturity level of an organisation, the greater the level of flexibility of the BI System required.

2.4.5. Risk management support

Risk management support is a BI capability to support decisions under conditions of future uncertainty (Isik, et al., 2012). BI systems and models have been applied in risk management contexts worldwide and have proven effective for over 50 year (Wua, et al., 2014).

All decision making includes an element of risk. BI Systems can be used to reduce risk in decision making. As the BI Maturity of organisations raise there is a greater demand for BI capability of Risk Management (Isik, et al., 2013). It can be argued that the BI Capability of Risk Management becomes more important to an organisation as the BI Maturity increases.

2.5. BI Maturity Models

Maturity models are often based on the Capability Maturity Model (CMM) which was designed for the software development process and based on the Maturity Thesis (Rajterič, 2010).

BI Maturity Models are used as a tool to assess the level of capabilities and usage of BI Systems within an organisation (Rajterič, 2010). Understanding an organisations maturity Level is critical in determining the level of BI adoption that is realistic with the organisation and provides a baseline from which organisations can strategically plan to increase their BI adoption and move to a new BI maturity. This decision to invest in increasing the organisations Maturity level needs to be assessed in terms of whether the organisation believes the increased usage will bring the added business value to warrant the investment spend (Raber, et al., 2012).

It is critical that an organisations BI system matches the BI Maturity Level of the organisation to get the most out of the system. In this sense an organisation benefits from understanding it's maturity Level before investing in expanding its BI Capabilities, both in terms of the Technical and Organisational Capabilities (Rajterič, 2010). It is important that organisations align BI Systems with its business effort and as such some organisations fit better with a lower maturity level than other organisations where BI is central to its Business.

There a number BI Maturity Models that have been developed and can be used by organisations for self assessment. However, the majority of these models have no grounding in accepted theoretical foundation. In an overview of 10 BI Maturity Models by (Raber, et al., 2012) there was only one that was explicitly based on a theoretical foundation from Information System theories and research, i.e. kernel theories.

Within this research the Author will be using a Maturity Model developed by Raber, Winter and Wortmann, that is based on Information System Success Models and their theoretical foundations (Raber, et al., 2012). This Maturity Model has been operationalised into

a Questionnaire that is aligned with BI capabilities from a technological and Organisational perspective (Raber, et al., 2012). This Model is comprised of five maturity dimensions strategy, organization, information technology (IT), quality and use.

To operationalise the Maturity Model, 25 items were identified as a basis to measure BI maturity across the five maturity levels. Using ideal maturity profiles, the distance of an organization to each maturity level by applying the Euclidean metric. The maturity level of the organisation is represented by the level with the smallest Euclidean distance. These 25 Items correspond to BI Capabilities which are categorised into the 5 Dimensions of BI Maturity.

2.5.1. Selected BI Maturity Model - Raber, Winter and Wortmann

The Bi maturity Model to be used in this research is the Raber, Winter and Wortmann Model developed in 2012 and operationalised in 2013 where a questionnaire was developed as an instrument to assess the BI Maturity of organisations.

There are 5 distinct Levels described in the Model:

2.5.1.1. Level 1 - Initiate

Level 1 of the BI Maturity Model represents an immature state of BI and is labelled as Imitate. In this Level BI organisation, responsibilities and sponsorship are ad hoc in nature without any standardisation. BI infrastructure is operational at a central level and basic capabilities are offered as ad-hoc services (Raber, et al., 2012).

2.5.1.2. Level 2 – Harmonize

Level 2 is labelled as Harmonise state. In this Level an organisations governance and organisational structure and setup is more centrally managed in terms of BI usage and control. The organisation is working to standardise operations, process, tools and applications that support

the BI usage and development. Although the policies and procedures are in place to help create consistency within BI, the IT infrastructure in place is still decentralised and there is limited standardisation of master data. BI System functionalities together with a high overall availability of BI systems enable increased business value which is utilised by senior management and for operational reporting. (Raber, et al., 2012).

2.5.1.3. Level 3 – Integrate

Level 3 is labelled as Integrate, and as the label suggests, at this level BI is centralised and data sources are integrated to provide a source of truth. There is also a IT Steering committee who develop BI strategies focused on to Technology and Tools. Organisational structures are in place to support the centralised BI systems usage and development. There is an emphasis on data quality control and maintenance to support the BI systems (Raber, et al., 2012).

2.5.1.4. Level 4 – Optimize

Level 4 is labelled as Optimize. At this level organisations are fully releasing the benefits and potential of an integrated and centralised BI system. Governance is well defined, and BI is a key part of Business strategy and BI Analytics are used to add and create Business Value. Middle management is widely engaged in BI usage.

2.5.1.5. Level 5 – Perpetuate

Level 5 is labelled Perpetuate. To achieve this highest level of BI Maturity there needs to be a continuous management of BI with a

focused BI strategy. BI Performance management and data quality management is place and pro-actively driven.

2.6. Relationship between BI Maturity Levels and BI Capabilities

A Maturity Model typically consists of a sequence of maturity levels for a class of objects (Becker, et al., 2009). Each level requires the objects on that level to achieve certain requirements. Maturity in this context is understood as a measure to evaluate the capabilities of an organization (Raber, et al., 2013).

The Maturity Model selected has been constructed based on the causes of Information System success. These success factors are the BI capabilities of Organisations. The BI Maturity levels are accordingly related to the BI capabilities. The Maturity Model selected uses five concepts which are related to different BI capability categories: Strategy, Social System/organisational Structure, Technical system/BI Tools and Infrastructure, Quality, and use/impact (Raber, et al., 2013).

The BI Maturity Model is designed to assess the strength of the BI Capabilities, and based on these strengths determines which Maturity Level for that dimension is reached. The Organisational BI Maturity Level is the lowest of the Levels reached by the dimensions. The BI Capabilities are the inputs that determine the BI Maturity Level.

However, the BI capabilities themselves can be analysed independently to determine their level or strength within the organisation.

The Author is examining 3 aspects to organisation BI Success in this paper which can be seen to be related. BI capabilities are related to BI Maturity and BI Capacities are related to BI Success. This frames the position that it can be argued that the relationship between BI Capabilities and BI Success may be influenced by the BI Maturity Level of the organisation.

2.7. Limitations of the Literature

The Research studies reviewed has similar limitations identified. There was a limited supply of BI experts and users to interview and this was within a limited scope of industries and countries. A bigger sample sizes would have been beneficial (Garcíaa & Pinzóna, 2017).

There is no consistent definition of what BI success looks like, and this makes it difficult to assess the relative responses of satisfaction of BI systems across various organisations and within organisations (Olszak, 2016). As sample sizes are limited in scope this means the results cannot be generalised to wider population of organisations (Yeoh & Popovic, 2016; Olszak, 2016).

In researching Decision environments relationship with BI success only two types of decision environments where included out of the nine identified types in the Gorry and Scott Morton framework (1971) (Isik, et al., 2013).

There are limitations in the research carried out on the Maturity Model instrument developed by Raber, et al. (2013). The questionnaire/instrument requires more elaborate and more detailed analyses to confirm its validity and reliability (Raber, et al., 2013). In order to confirm the results of the proposed maturity measurement instrument interviews should be conducted to confirm the results of the proposed maturity measurement instrument (Raber, et al., 2013).

2.8. Future research suggested by the Literature

It is suggested to continue further research into the Critical Success Factors and BI Capabilities. The limitations noted by the Literature refer to the need for further research to extend the understanding of how BI Success is related to the various Success Factors and BI Capabilities. It

is suggested that it would be valuable to extend the scope and scale of the research as the existing research samples are too small to allow results to be generalised. Existing research has a limited breadth, depth of analysis and limited scope (Yeoh & Popovic, 2016).

Organisations implement BI systems for different reasons, and therefore success needs to viewed through the context of the organisations success criteria (Isik, et al., 2013). With the variable nature of organisations, more in-depth analysis of BI Implementations across different organisations is an important and valuable area of research.

There are a large number of factors that relate to BI Success, and it is suggested that more research is required to look at how these factors and capabilities interrelate (Isik, et al., 2013). One of the BI Capabilities discussed in this context is BI Flexibility which was shown to have a positive relationship with BI Success and was shown to be more strongly related when decision making types are unstructured, and when more strategic information processing is required. It is suggested that future research in this area should look to expand on the decision types incorporated in the study (Isik, et al., 2013).

Also noted was further research in how to BI can be used to build business success (Olszak, 2016).

The Research studies reviewed in this document are snapshots of the BI Capabilities of organisation at that point in time. Considering how BI capabilities can develop within an organisation over time and as the BI maturity levels increase, it is suggested that longitudinal studies that consider this development would add to the understanding of BI Capabilities over time (Torres, et al., 2018).

For Future research on Maturity Model developed by Raber, et al. (2013) a larger number of organisations should be analysed (Raber, et al., 2013).

3. Research Methodology and Methods

3.1. Introduction

The purpose of this research proposal is to better understand the key BI Capabilities that are required for BI Success. There is currently no academically accepted best practice for BI Success (Garcíaa & Pinzóna, 2017). There is a large number of variables within the different organisations attempting to implement and utilize BI. The existing research undertaken on BI success is not sufficient to gather enough information to model BI success (Rashdi & Nair, 2017).

It is proposed for this research to further examine the relationship between BI capabilities and BI success and extend aspects of research carried out by Popovič, et al. (2012) and Isik, et al. (2013). Popovič, et al. (2012) carried out research on the relationship between BI Maturity and culture to BI Capabilities and this research study will also be using Maturity Models developed by (Raber, et al., 2012) that are designed based on Information system (IS) kernel theoretical models and have been operationalised into a questionnaire format which will be used as an instrument in this research study.

Research can be described as something that is undertaken to find out something in a systematic was which increases knowledge. The key terms in this definition are that we find something out and that it is done in a systematic way (Saunders, et al., 2009, p. 5).

Methodology refers to the theory of how research should be approached and undertaken (Saunders, et al., 2009, p. 3).

This chapter will cover the key implements of the research methodology used and the reasons for selecting those methods. Namely a quantitative methodology approach using inductive approach, which looks to examine the relationship between BI

Capabilities and BI Success and the influence that the organisations BI Maturity has on that relationship.

3.2. Proposed Research Methodology

In order to develop the research approach in a structured way the research methodology adopted in the dissertation was developed from the Research Onion (Saunders, et al., 2009, p. 108) which served as a guide in the process.

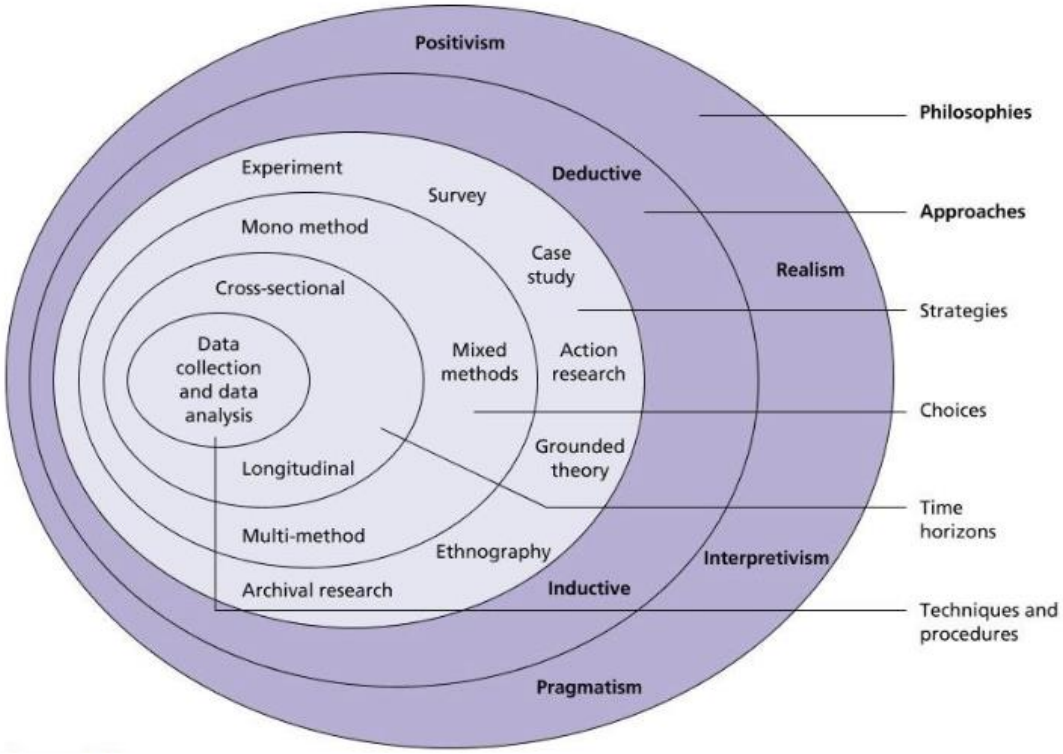

Figure 2 The Research 'Onion'

(Saunders, et al., 2009, p. 108)

The outer layers of the Research Onion relate to the research philosophies and approaches. The next layers relate to research strategies, and the middle of the onion involve data collection and analysis.

3.3. Research Philosophy

The first layer in the onion refers to the Philosophical approach of the research.

Three major philosophies include:

- Ontology: The researcher's view of the nature or reality or being
- Epistemology: The researchers view regarding what constitutes acceptable knowledge
- Axiology: The researchers view of the role of values in research

(Saunders, et al., 2009, p. 119)

The researcher adopted an Epistemology approach to the research as questionnaire answers were considered acceptable knowledge for this research. As there may be bias within individuals answering these questions, a positivism approach was taken with highly structured questionnaires and ideally large samples.

However, within the limited resources available to the researcher for this study, a Positivism Approach is used where only Quantitative research is carried out. A pragmatism approach would have lead the research towards a mixed method approach which combined a interpretivism and positivism approach. Being able to select valid people to be interviewed was not possible for the researcher and hence a positivism approach was used.

The functional interaction between the researcher's epistemological view and the applied research philosophy positivism would allow a fact based conclusion of the relationship between BI capabilities, BI Success and the influence BI maturity has on the relationship.

3.4. Research Approach

The research approach can be deductive or inductive. In this study the research approach taken by the researcher is Deductive.

The approach is more in keeping with the research question as the researching is attempting to test an operationalised hypothesis, where the hypothesis has been deduced based on existing research and theories on the relationships between BI capabilities and BI Success.

The other option was to use inductive approach which would lend itself to conducting interviews using a qualitative approach with suitable individuals and build a theory or hypothesis based on the output of the interviews. This would have been more in keeping with an interpretivism approach which was not the approach selected for this dissertation. However, from a critical standpoint, the researcher believes a pragmatic approach which included both quantitative and qualitative approach would be beneficial to the research and regards this approach for future research undertaken in this area (Saunders, et al., 2009, p. 119).

3.5. Research Strategy

The Researcher decided to adapt existing questionnaires which gathered data relating to BI Success, BI capabilities and BI Maturity Models.

The choice is in line with the research philosophy and approach used by previous studies (Salmasi, et al., 2016; Popovič, et al., 2012; Isik, et al., 2012; Raber, et al., 2013).

The questionnaire was used in the form of an anonymous online survey. Using a survey approach has an advantage as it is easy to understand and complete. The researchers bias can not be imparted of the people completing the survey and as the questions have been

adapted from existing questionnaires that have been tested for validity and reliability it is deemed a sensible and practical approach to take.

An online survey approach gives an opportunity to generate findings from a larger sample at a lower cost.

3.6. Research Choice

Research choice was a quantitative approach. The Researcher decided to use adapt existing questionnaires which gathered data relating to BI Success, BI capabilities and BI Maturity Models.

With greater resources at time available the choice of quantitative and qualitative would have been an optimum selection for researching this topic. With viewpoint is consistent with commentary from previous studies (Raber, et al., 2013; Popovič, et al., 2012).

3.7. Secondary data collection

The Sources used to construct the literature review are Academic journals that include keywords relating to BI, Business Intelligence, Success Factors, BI Capabilities, BI Maturity Models, Data Quality, Information Systems.

Also included are web searches with the same keyworks.

Theories related to BI Success factors and Maturity Models were also included in the research.

3.8. Quantitative Primary data Research

A survey was used to verify the proposed hypotheses. The questionnaire was structured with a five-point Likert scale for all three sections containing 47 questions.

The first part contains 5 questions and measures the dependent variable, BI success. In this section BI satisfaction is taken as a substitute for BI success (Lönnqvist & Pirttimäki, 2006).

The second part measures the variable BI data quality. The Items in both section one and two where adapted from a Survey constructed to measure the relationship between BI Success and BI Capabilities (Isik, et al., 2012). The BI capabilities were operationalized with items developed based on the Gartner Group reports (Isik, et al., 2012). The questions in section two were split into 3 sub sections relating to different aspects of Data Quality Capability. These were Data Quality, Data Reliability and Data Source Quality. Each of these sub sections contained 4 questions.

The Third section of the survey measure the moderating variable, BI Maturity of the organisation. This section contains 25 questions. The section of the survey was taken from previous research to operationalise a Maturity Model based on BI capabilities and Information System theories (Raber, et al., 2012; Raber, et al., 2013). This third section looked at the extent of how BI was used within the organisation as well as the reliance and trust of the BI system and reports within the organisation. The questions could be used to calculate the BI Maturity of the organisation by using methods developed by Raber, et al. (2013) to operationalise their BI Maturity Model using the questionnaire as the instrument.

The survey questionnaire was an online survey that was anonymous and self-completed. There are advantages and disadvantages in using this form of survey. A disadvantage is that the researcher cannot control the environment in which the survey is completed. There may be conditions that create a bias while the survey is being completed. There is no control over how the surveys are completed or interpreted

which may lead to reliability issues. There is no control over the sample so targeting the relevant people can be difficult to achieve.

The major advantage of using online survey is that it can be produced at low cost and quicker than in person surveys. It allows for a larger sample to be generated. This larger sample can lead to mitigating any environment control concerns as noted in previous paragraph. Another advantage of using a survey is that any unconscious bias from the researcher is removed. As the survey question have been adapted from surveys within peer reviewed research the reliability and validity of the questions can be argued to be of required standard.

The speed at which online surveys can be returned is also key advantage as there are time constraints associated with the completion of the dissertation.

For speed of completion and to maintain anonymity of the participants there were no category questions related to the users role or industry of the organisation. This has the added benefit of having a consistent question style survey, but would reduce the potential to gain insight into BI perceptions related to user roles and organisation industries. As noted all questions were based on a 5 point scale and as such were closed ended questions. There was no writing required by the participants and they only needed to select a single option on the 5 point scale for each question.

For Sections one and two the 5 point scale had the following answer options:

- Strongly dissatisfied, Dissatisfied, Neither Satisfied nor dissatisfied, satisfied, Strongly Satisfied.

For Section three the 5 point scale had the following answer options

- Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly Agree.

3.9. Sample

This survey is constructed for people who are consumers of BI or work in a BI environment, and where these people are working in Organisations that have a BI System in place. The Organisation can be at any BI Maturity Level.

As the population of this specific audience is very large, sampling is required for a number of reasons, including: It would be impractical to survey the whole population, the researcher does not have the budget to survey the entire population, time constraints to conduct the survey, and time constraints to analysis the data (Saunders, et al., 2009, p. 212)

Sampling techniques include Probability and Non-probability. In this cause the researcher has used a Non-probability technique by selecting individuals known to the researcher who meet the criteria to be included in the research scope population. The individuals were also asked to share the survey link with other individuals who they know to also meet the criteria within or outside their organisation.

This is non-probably sampling as everyone in the population did not have an equal probability of being selected for this research.

Using Probability sampling would have led to potentially better results as non-probability sampling can lead to a bias in the results and the non-probability method is more subjective. However, for practical reasons non-probability sampling was used for this research.

The selection of the sample was carried out through convenience and this is described as convenience sampling (Saunders, et al., 2009, p. 236).

The survey was sent out to 43 people from 9 organisations.

3.10. Analysing Quantitative Data

The data generated consisted of ranked (ordinal) data. The five ratings questions in the questionnaire asked participants to pick alternatives on how strongly they agree with a statement on a five-point Likert-style ranking.

The analysis was required in the areas listed below:

1. Analysis the BI Success
2. Analysis the BI Quality Capability strength
3. Calculate the BI Maturity of the organisation
4. Calculate the relationship between BI Success and Strength of Quality
5. Calculate the moderating factor of BI maturity Level with the relationship between BI Success and BI Quality

To analysis the relationship between BI Success and BI capabilities these variables were averaged and then z-scores calculated within an Excel spreadsheet.

The z-scores were calculated for the three aspects of BI quality Capability: Data Quality, Data Reliability and Data Source Quality. The Pearson's r was calculated to show the relationship between each of the 3 aspects of Quality and the BI Success. The p-value would then be calculated to determine whether the Null Hypothesis can be disregarded. The null Hypothesis being that there is no relationship between BI Success and BI Quality Capabilities.

The BI Maturity of the organisation will then be calculated as per the method outlined by Raber et al (2013) for each response in the survey. This calculation approach was developed by adapted an approach from the original theoretical works of Sabherwal & Chan (2001).

The Euclidean distance is computed for each of the five BI maturity dimensions of an organization between all 25 items that are part of the BI Maturity section of the survey. This results in five distances to each maturity Level. The Smallest distance is the overall BI maturity Level for the organisation in that Reponses (Raber, et al., 2013).

This is represented as:

DistD(l) = Square Root(Sum of $(x-v)^2$)

Where:

- l = each Maturity Level from 1 to 5
- x = Score from each of the 25 items
- v = the Specific maturity level value (1 to 5 dependent on l)

The resultant Maturity Level is then calculated as

LevelD = m, such that DistD(m) = min(DistD(l) for m = 1 to 5

This can be expressed by saying the Resultant Maturity Level is the Maturity level with the smallest calculated DistD.

To determine if the BI Maturity level has an influence on the relationship between BI Success and BI Quality, the Pearson r coefficient will be calculated for each group of BI Maturity levels contained in the sample and there will be compared.

The Hypothesis is that the BI Quality will have a higher r coefficient the higher the level of BI Maturity.

3.11. Ethical Issues

The researcher took care to ensure there were no ethical issues throughout the research process.

The Survey was anonymous and no personal information was collected. No data related to the organisation was collected.

The data was collected for the purpose of the dissertation only, and will be deleted upon completion.

The survey was explicated stated as being voluntary and no pressure was applied to force completion as the participants could withdraw at any stage from the survey.

3.12. Limitations to Research

Understanding and highlighting Limitations to Research are important in order to put the findings and analysis into context (Ioannidis, 2007).

This Study had some limitations which will be outlined so that they can be brought into consideration for future studies, and so that the findings and discussions can be brought put into context with the studies limitations.

The Sample size was too small to bring a high level of confidence into the results. The larger the sample to higher the probability of a more accurate reflection of the relationships between BI success and BI Quality capability in the of BI Maturity Levels.

The sample should also be broadened into different countries and industries.

The study would benefit from having respondents from a mix of organisations with different BI Maturity Levels. This study did not have a sample from all Maturity levels and this restricted the comprehensiveness of the research in relation to the examination of

the influence of BI Maturity Levels on the strength of the relationship between BI Success and BI Quality Capabilities.

As this sample was convenience sample and of a small size, care should be taken if generalising the results (Isik, et al., 2013).

Regarding the research instrument itself, the survey questionnaire, because the variables to determine BI Success and Quality Capabilities were measured in the same questionnaire, common methods bias could have been introduced (Mudzana & Maharaj, 2017).

The survey was an online survey so the environment could not be controlled and there was no opportunity to assist if the respondents required clarifications for any of the questions. This could lead to a bias being introduced in the questions.

There was no qualitative analysis carried out which would have been beneficial to validate the interpretation of the questions posed to the respondents. This is especially the case with regards the items related to the measurement of the BI Maturity Level of the originations. This instrument has been developed recently and the researchers note that they plan to carry out qualitative interviews in the future to assess the BI Maturity level of some organisations which have previously participated in the their survey in order to confirm the results and potentially allow them to refine their questionnaire (Raber, et al., 2013). This acknowledgement by Raber, et al (2013) clearly highlights the need for further validation of their BI maturity assessment research and brings this limitation into this study's findings.

This study also only addressed the relationship of the BI capability concerning Quality. There are many other important Capabilities that should be considered. However, for this study the researcher selected quality as it is a BI capability that is very important Capability and one of the most important success factors (Yeoh & Popovic, 2016) and Data quality is easy for respondents to understand in a consistent context.

4. Analysis and Findings

The Data Collection for this research was carried out using an online survey that was used to calculate the respondent's BI satisfaction, Strength of BI Quality capabilities in their organisation and the BI Maturity Level of their organisation.

47 People were requested to complete the survey across 9 organisations. The people targeted were people who used BI systems or were BI Professionals in their Organisations. The Organisations were expected to have range of differing BI maturity Levels.

Of the 47 people requested to complete the survey, 21 people submitted responses. This represents a 45% completion rate. Low samples such as these should be taken into account for any findings from the research results and when using the results to present generalised conclusions (Isik, et al., 2013).

4.1. BI Success Analysis

BI Success is calculated by using BI satisfaction as a proxy. How satisfied a user is with the BI system is often used as a proxy for how success the BI system is (Isik, et al., 2012).

The BI Success section of the Survey incorporated 5 items using a 5-point Likert scale. The average result was used to determine the overall BI Success result for each respondent.

Cronsbach's alpha was calculated to determine the consistency of the results. The value calculated was 0.85619. This is considered a good result and confirms the consistency of the items.

Table 1 - BI Satisfaction response percentages

BI Satisfaction response percentages

BI Satisfaction items	Strongly dissatisfied	Dissatisfied	Neither Satisfied nor dissatisfied	satisfied	Strongly Satisfied
How well you are satisfied with the BI system overall	0%	29%	0%	62%	10%
How well the BI that you are using provides precise information you need	5%	24%	10%	62%	0%
How well the BI that you are using supports your decision making	0%	29%	0%	62%	10%
How well the BI that you are using provides information you need in time	14%	19%	10%	29%	29%
How user friendly the BI that you are using is	0%	0%	0%	86%	14%
Overall Result*	**0%**	**24%**	**5%**	**71%**	**0%**

*To calculate the Over Result the average score per respondent was rounded to nearest whole number.

Visually the Overall Results correlation with the individual item percentage scores aligns to the high Cronbach's alpha score.

The Mean result for BI satisfaction across all respondents was 3.4 which equates to Neither Satisfied nor dissatisfied with a Standard deviation of 0.833. However, a more meaning analysis shows that the respondents fall into two main categories, those that are dissatisfaction with their BI system and those that are Satisfied.

The results also show that the BI systems themselves are generally considered easy to use, which is demonstrated by the fact that 86% of respondents were satisfied by how user friendly their BI systems were and 14% were very satisfied, but that the underlining Data Quality and

scope of data are key determinants in the perception of overall satisfaction.

4.2. BI Quality Capability Analysis

BI Quality Capability is split into 3 specific areas of BI Quality. These are Data Quality, Data Reliability and Data Source Quality.

Each of these aspects of Quality will be analysed separately

4.2.1. Data Quality

Table 2 – BI Data Quality response percentages

BI Data Quality response percentages

BI Satisfaction items	Strongly dissatisfied	Dissatisfied	Neither Satisfied nor dissatisfied	satisfied	Strongly Satisfied
Accuracy of data	0%	24%	29%	38%	10%
Comprehensiveness of data	0%	19%	29%	43%	10%
Consistency of data	0%	24%	14%	62%	0%
Quality of data	14%	14%	0%	62%	10%
Overall Result*	**0%**	**24%**	**14%**	**52%**	**10%**

*To calculate the Over Result the average score per respondent was rounded to nearest whole number.

52% of respondents had an average score of Satisfied when rounding the average to the nearest whole number.

The Cronbach's alpha was 0.918 for the Data Quality items and this shows that the questions have a high level of consistently and this represents a high coefficient of reliability (Wieder & Ossimitz, 2015).

4.2.2. Data Reliability

Table 3 – BI Data Reliability response percentages

BI Data Reliability response percentages

BI Satisfaction items	Strongly dissatisfied	Dissatisfied	Neither Satisfied nor dissatisfied	satisfied	Strongly Satisfied
Reliability data collected for BI	10%	24%	10%	48%	10%
Resolution of inconsistencies and conflicts in the data collected for BI	10%	5%	43%	43%	0%
Accuracy of data collected for BI	10%	38%	0%	33%	19%

Recency of data collected for BI	0%	10%	10%	52%	29%
Overall Result*	**0%**	**10%**	**29%**	**52%**	**10%**

*To calculate the Over Result the average score per respondent was rounded to nearest whole number.

52% of respondents had an average score of Satisfied when rounding the average to the nearest whole number. This was the same result as for Data Quality.

However, the Cronbach's alpha was 0.767 for the Data Reliability items and this shows that the questions have a lower level of internal consistently. However, having a Cronbach's alpha over .70 is still considered high enough to be deemed reliable (İNAL, et al., 2017).

4.2.3. Data Source

Table 4 – BI Data Source response percentages

BI Data Source response percentages

BI Satisfaction items	Strongly dissatisfied	Dissatisfied	Neither Satisfied nor dissatisfied	satisfied	Strongly Satisfied
Availability of data sources used for BI	29%	10%	19%	19%	24%
Usability of data sources used for BI	0%	33%	14%	29%	24%

Ease of understanding of data sources used for BI	0%	24%	24%	38%	14%
Conciseness of internal data sources used for BI	0%	19%	33%	38%	10%
Overall Result*	**0%**	**19%**	**29%**	**29%**	**24%**

*To calculate the Over Result the average score per respondent was rounded to nearest whole number.

The average results for the Data Source quality had a more even distribution than Data Quality and Data Reliability measures. The highest grouping for respondents was an average score of Satisfied when rounding the average to the nearest whole number, which was the average result for a third of the respondents.

However, the Cronbach's alpha was 0.8503 for the Data Source items and this represents a high level of internal consistency and reliability of the items.

4.3. Relationship between Success and Quality types

The measure the relationship between Data Quality and BI Satisfaction the Persons correlation r coefficient was calculated.

Pearson's r quantifies the level or degree of linear association between two variables. The correlation can be negative or positive. If it is positive this implies that as one variable increases the dependent variable will also increase, and if it is negative this implies that as one variable increased the dependent variable will decrease. The Person correlation is range bound and can only range from 1.0 to −1.0 (Gignac, 2019, p. C3.2).

The Pearson's r coefficient was calculated by the method outlined below:

1. The z-score was calculated for each of the four item sets – BI Satisfaction (Zsat), BI Data Quality (Zq), BI Data Reliability (Zr), BI Data Source Quality (Zs)
2. The sum of the z-scores was calculated for each pairing – ΣZsatZq ΣZsatZr ΣZsats

Pearon's r = ΣZxZy/(number of respondents – 1)

The z-score was calculated from the formula (Score – Mean Score)/Standard Deviation. The raw Scores were transformed into Standardised score so that we can compare two scores that have a different normal distributions (Gignac, 2019, p. C2.15).

To determine whether there is a statistically significant effect, the p-values were then calculated for each Hypothesis (Gignac, 2019, p. C3.5).

Table 5 – Relationship between BI satisfaction and BI Quality Capabilities

Relationship between BI satisfaction and BI Quality Capabilities

	Pearson's r	p-value
Data Quality	0.932	0.001
Data Reliability	0.349	0.121
Data Source	0.262	0.251

The results show that there is a very strong positive correlation between BI Satisfaction and Data Quality Capability which has a very low p-value indicating that this is a statistically significant effect.

This relationship is supported by previous research carried out in the area (Isik, et al., 2012; Yeoh & Popovic, 2016).

The lack of correlation with Data Reliability and Data Source Quality can not be used to form any conclusion with confidence as the p-values are too high to use as evidence for conclusions.

4.4. BI Maturity Analysis

The BI Maturity of each respondent's organisation was calculated based on answers from 25 items in the survey. Using ideal maturity profiles the Euclidean distance was measured against each Maturity Level and the resultant Maturity level for the organisation was the Maturity Level with the smallest Euclidean distance (Raber, et al., 2013).

The Cronbach's alpha was 0.9605 for the 25 items used to calculate the Bi Maturity of the organisations. This represents a high level of internal consistency and reliability of the items.

Of the 21 respondents, there were 4 whose Organisations had a Maturity Level of 2, 9 with a maturity level of 3 and the remaining 7 had a maturity level of 4.

There were no organisations with a Level 1 or Level 5 in the survey results.

The mean BI Satisfaction and BI Quality Scores were calculated for each Maturity Level grouping as per table xx below.

Table 6 – Mean BI Satisfaction and BI Quality Scores per Bi maturity level

Bi Maturity level	Number of Respondents	Mean BI Satisfaction	Mean BI Quality	Mean BI Reliability	Mean BI Data Source
Level 2	5	3.0	2.4	2.7	2.4
Level 3	9	3.4	3.4	3.7	3.9
Level 4	7	4.2	4.1	3.6	3.2

This table shows an interesting trend that as an Organisation develops the BI capabilities to rise to a higher Maturity level, the overall satisfaction with BI in the Organisation tends to increase.

4.5. Influence of the Maturity on the relationship

Table 7 – Relationship between BI satisfaction and BI Quality Capabilities per Maturity Level

		BI Satisfaction/ BI Data Quality		BI Satisfaction/ BI Data Reliability		BI Satisfaction/ BI Data Source	
BI Maturity level	Number of Respondents	r	p-Value	r	p-Value	r	p-Value
Level 2	5	0.998	0.000	-0.998	0.000	-0.890	0.000
Level 3	9	0.938	0.000	0.799	0.010	0.544	0.130
Level 4	7	0.782	0.038	0.674	0.097	0.560	0.191
Combined	21	0.932	0.000	0.349	0.121	0.262	0.251

Table 7 above shows the Pearson's r Coefficient for the relationship between Bi satisfaction and each of the 3 types of BI quality Capability measured, and its corresponding p-Value.

The strongest relationship across all 3 Levels identified is between BI Satisfaction and BI Quality. At level 2 there is a surprising result of a

negative r coefficient with regards BI Risibility and BI Data Source. Looking directly at the results the author does not believe any conclusion can be drawn from this due to the small sample numbers for Level 2. For these results the Higher BI satisfaction scores respondents scored their Data Reliability and Data Source Capabilities slightly higher than the respondents who scored their over BI satisfaction lower. Perhaps this highlights how BI Satisfaction is more dependent on Data Quality available to the users at low BI maturity Organisations.

4.6. Hypotheses Results

H1a: Data Quality has a positive relationship with BI Success

The coefficient for this was calculated at 0.932, which is evidence of a strong positive relationship between BI Satisfaction and BI Data Quality. The P-value was calculated at 0.0001 which is below the 5% mark which means the interaction effects are statistically significant (Isik, et al., 2013).

With this the author concludes that the Null Hypothesis can be ignored and that we can accept the H1a hypothesis.

H1b: The relationship between Data Quality and BI Success is positively influenced by Level of BI Maturity

When the relationships were calculated for each separate BI Maturity level it was found that for Data Quality there was a negative influence on the Relationship between BI Maturity level and the relationship between BI Satisfaction and Data Quality Capability.

For Level the r coefficient was 0.998, for Level 3, 0.938 and Level 4,0.782.

The p-values were below the 5% mark to support evidence that this result was statically significant. Due to the small sample caution is advised to generalise the results with confidence.

H2a: Data Reliability has a positive relationship with BI Success.

The coefficient for this was calculated at 0.349, which is evidence of a moderate positive relationship between BI Satisfaction and BI Data Reliability. The P-value was calculated at 0.121 which is above the 5% mark which means the interaction effects are not statistically significant (Isik, et al., 2013).

With this result the author cannot discard the NULL hypothesis and we can not use this as evidence to support the Hypothesis H2a.

H2b: The relationship between Data Reliability and BI Success is positively influenced by Level of BI Maturity

Level 2 Maturity displays a strongly negative relationship between BI Satisfaction and BI Data Reliability, while Level 3 and 4 display a positive relationship. However due to the small sample sizes and high p-values the author does not believe the Null Hypothesis can be discarded but feels to is merit potential merit in Bi Maturity Levels having a moderating influence on the relationship between BI satisfaction and BI Data Reliability. There is evidence that BI Reliability is more important factor for the higher Maturity Levels but not enough evidence to fully support it.

H3a: Data Source Quality has a positive relationship with BI Success.

The coefficient for this was calculated at 0. 262, which is evidence of a moderate positive relationship between BI Satisfaction and BI Data Source. The P-value was calculated at 0. 251 which is above the 5% mark which means the interaction effects are not statistically significant (Isik, et al., 2013).

With this result the author cannot discard the NULL hypothesis and we can not use this as evidence to support the Hypothesis H2a

H3b: The relationship between Data Source Quality and BI Success is positively influenced by Level of BI Maturity

Level 2 Maturity displays a strongly negative relationship between BI Satisfaction and BI Data Sources, while Level 3 and 4 display a positive relationship. However due to the small sample sizes and high p-values the author does not believe the Null Hypothesis can be discarded but feels to is merit potential merit in BI Maturity Levels having a moderating influence on the relationship between BI satisfaction and BI Data Source Quality. There is evidence that BI Data Source Quality is more important factor for the higher Maturity Levels but not enough evidence to fully support it.

5. Discussion

5.1. Relationship between BI satisfaction and BI Quality

The first discussion point is related to what we can confirm about the relationship between BI satisfaction and BI Quality.

Previous research has provided evidence that there is a positive relationship between BI Quality and BI satisfaction (Isik, et al., 2013; Garcíaa & Pinzóna, 2017; Yeoh & Popovic, 2016). This research study supports those findings. However, this research goes a step further within the context of quality in two ways, firstly the researcher examines the relationship between BI satisfaction and BI quality by looking at Quality within the lenses of Data Quality, Data Reliability and Data Source Quality to get look to gain further insight into the BI Quality capability and its relationship with BI Satisfaction, and also to examine the influence of BI maturity on that relationship.

The relationship was found to be consistent with Data Quality across the Maturity Levels, but there is an apparent shift in the relationship with Data Reliability and Data Source quality as the BI Maturity Levels increase.

It is proposed that this behaviour should not be surprising when considered in the context of; how BI Systems are used in organisations of different Maturity Levels; and in how BI Satisfaction (Success) is a subjective scores related to the expectation of the BI system User, rather than measuring the value of the BI system to the Organisation (Isik, et al., 2012).

5.2. Maturity Level influence

These results support the conclusion that when an Organisation has a low BI Maturity Level there is less reliance on the BI System in the context of the Business Decision making support systems and hence the user expectation of the BI System would be less (Rajterič, 2010). For an effective Business Decision support system to be utilised by organisations it is necessary for all key data sources to be integrated and provide consistent and reliable data and information (Isik, et al., 2013). For a BI system to provide support for a Decision support system it follows that Data Reliability and Data Source quality become

increasing more important to fulfil the expectation of a BI system user in a High Maturity level organisation.

This insight in the research may help future research build on this to be able to create an operational guide to outline a framework to help organisations move up to higher Maturity Levels. When building a plan for Implementing and growing a BI system within an organisation, the logical steps are to focus on data quality first of key system before embarking on potentially expensive IT projects to integrate multiple internal and external data sources and also look at increasing the reliability of the data through IT infrastructure and Business Process control projects. As outlined by Rashdi & Nair (2017) it is necessary to assess an organisations maturity model to determine its capabilities, the needs of the organisation and also the availability of the data sources to the organisation.

It is interesting to note that BI Satisfaction/Success as measured in this research does not significantly change based on the BI Maturity Level that the organisation has achieved. It can be argued that at an objective level the BI system should be better within Organisations that have achieved a higher BI Maturity Level, yet as this research uses a subjective approach to calculating the BI Success it is not apparent in the results, as expectation is key to perceived satisfaction (Fourati-Jamoussi & Niamba, 2016). It can be argued that this is a flaw in the approach taken for this research and that Business Value is the real measure of Success. From a different perspective it can also be argued that you can not view Business Value of BI systems as a true measure of success either because the return on investment of the BI system should be taken into account in order to measure true benefit or success (Nofal & Yusof, 2013).

A Low BI Maturity Organisation may invest a small amount of resources to provide a BI System that successfully serves a purpose to its BI users, but does not provide a high level of information or capabilities to

support the organisations Decision support systems. Investing in further BI capabilities may not add any net benefit to the organisation.

Taking these points into account the advice for future researchers is that they should look at user Satisfaction with BI system, objective evaluation of the BI system and also the Business Value added by the BI system I order to fully score the success of a BI System.

It should be noted that the score of whether the users thought the BI system they used was user friendly and easy to use was consistently high regardless of the overall satisfaction with BI. This suggests that the modern software available for BI system is of a high standard and that regardless of BI Maturity the software being implemented is very easy to use.

This is consistent with evolution of Bi Systems and how they can be implemented. Historically it would have been a huge investment to introduce a BI system, but with the advent of Software as a Service (Saas) and a more competitive BI software market it has become much cheaper for organisations to implement BI Systems (Fourati-Jamoussi & Niamba, 2016).

5.3. Research study Limitations

As the sample size was small with 21 respondents any generalisations of the results should be used with caution. It would be recommended to redo the research with a larger sample size that includes an even spread across organisations with different BI Maturity Levels. The objective of providing evidence that the Maturity Model influences the relationship between BI satisfaction and BI Quality capability was only partially achieved due to the small sample size, however it did provide indications that there is validity in the theory that there is a relationship.

This research did not have any qualitative research and this would have been beneficial to validate the understanding of respondents of the

questions being asked of them in relation to assessing the BI Maturity levels. This was noted in the research carried out by Raber, et al (2013). Previous studies have used semi-structured interviews of purposefully selected individuals to gain a deeper understanding of BI issues (Olszak, 2016).

Bi satisfaction was used as a proxy for BI success. The limitation of this is important to understand in the context of the results as this can be skewed by user perception and may not account for objective success for the organisation in terms of Business Value added and return on investment.

5.4. Practical Implications

The practical Implications for this research are related to how organisations should focus on data quality as the primary quality capability while working on increasing BI system adoption and improving its value to the business.

Also, implications that as users consistently felt the BI systems were easy to use and provided the functionality required, organisations do not need to invest upfront on expensive BI systems, but can start at a low level which will provide value and user satisfaction. Organisations can then decide whether further BI adaption would add value to the Business. At a stage were an organisation decides to adopt a strategy of increasing their BI maturity, it will then be important to invest on data Reliability and data source quality to maintain levels of BI satisfaction.

5.5. Potential Future Research

Areas for future research could focus on redoing similar research but expanding on sample size across more BI users and more organisations.

This research only focused on BI Quality capability and future research should expand the research scope to include other BI capabilities that are critical to BI success.

Using qualitative studies to validate the BI Maturity Levels of organisations would be beneficial, as this study used an Online survey instrument addressing multiple variables and as such could have introduced bias.

Further research to validate the instrument used to assessment BI Maturity Levels would also be of value to the area of furthering BI System knowledge.

6. Conclusion & Recommendations

6.1. Conclusions

BI is increasing more important to business and they are becoming more reliant on them to help provide quicker and more accurate answers and decisions so that they can adapt in changing market places (Yeoh & Popovic, 2016).

Business Guidelines and advice are sorely needed as currently failure rates for BI are still very high and BI is one of the top agendas for Senior Management and executives (Garcíaa & Pinzóna, 2017).

Existing Research is lacking the breadth and dept to required to build a frame work for BI implementation and Adoption, or in guiding on capabilities required to increase BI maturity Levels (Olszak, 2016).

Limitations in previous research underlines the need for extensive research.

This research studies expends on previous research and combines complementary research topics of BI Capabilities and BI Maturity

Models in a new and important manner that can be used as a basis for future research.

The research carried out provided insights into the relationship between BI Quality Capability and BI Success and showed how different aspects of Quality are more relevant and potentially more important depending on the what BI Maturity level an organisation is at. This can lead to insights for organisations developing strategies to increase their Maturity levels, or improving the BI satisfaction within the Maturity level they want to remain in.

This research validates conclusions from previous research that BI Success and BI Quality Capabilities are strongly related (Yeoh & Popovic, 2016; Garcíaa & Pinzóna, 2017).

This research uses BI Maturity Model developed by Raber, et al., (2013) to illicit insight into how an Organisations BI Maturity Level can influence the importance Quality Capabilities in the context of providing a successful BI system to its users.

Based on these insights the research indicates that based on an organisations Maturity level, different aspects of BI Quality Capabilities are more important than others. Specifically, the research points to Data Quality being a fundamental aspect that is required regardless of Maturity Level, but Data Reliability and Data Source Quality may be less important at low Maturity Levels and become more important as an organisation moves into Maturity Levels 3 and 4. The implications for this in regards organisations developing BI data strategies are outlined in the below section.

6.2. Recommendations

6.2.1. Recommendations for future research

Areas for future research could focus on redoing similar research but expanding on sample size across more BI users and more organisations.

This research only focused on BI Quality capability and future research should expand the research scope to include other BI capabilities that are critical to BI success.

Using qualitative studies to validate the BI Maturity Levels of organisations would be beneficial, as this study used an Online survey instrument addressing multiple variables and as such could have introduced bias.

6.2.2. Recommendations and implications for organisations and management

Organisations should decide what BI Maturity Level is best for your organisation. Self-assessment using the questionnaire using in this research would be a valuable tool and step in understanding the organisations Level. Outside of the assessment, qualitative assessment of the organisations BI Capability Strengths should be undertaken which should validate findings from the self-assessment questionnaire.

Organisations should prioritise Data Quality if this is not at a strong point before investing in Data Reliability and Data Source capabilities.

Important to note that as this research only looked at data quality, and consequently this recommendation is only limited to investment within Quality capability and does not intend to offer strategy advice for strengthening other Bi capabilities and there is no intention to indicate other BI capabilities may be less important for an organisations BI Success.

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Appendices

6.3. Appendix 1: Research Questionnaire

Item #	Questionnaire Items
	BI Satisfaction Section : Scale used - Strongly dissatisfied (1);dissatisfied (2);Neither Satisfied nor dissatisfied(3);Satisfied (4);Strongly Satisfied(5)
1	How well you are satisfied with the BI system overall
2	How well the BI that you are using provides precise information you need
3	How well the BI that you are using supports your decision making
4	How well the BI that you are using provides information you need in time
5	How user friendly the BI that you are using is
	BI Data Quality Section : Scale used - Strongly dissatisfied (1);dissatisfied (2);Neither Satisfied nor dissatisfied(3);Satisfied (4);Strongly Satisfied(5)
6	Accuracy of data
7	Comprehensiveness of data
8	Consistency of data

9 Quality of data

BI Data Reliability Section : Scale used - Strongly dissatisfied (1);dissatisfied (2);Neither Satisfied nor dissatisfied(3);Satisfied (4);Strongly Satisfied(5)

10 Reliability data collected for BI

11 Resolution of inconsistencies and conflicts in the data collected for BI

12 Accuracy of data collected for BI

13 Recency of data collected for BI

BI Data Source Section : Scale used - Strongly dissatisfied (1);dissatisfied (2);Neither Satisfied nor dissatisfied(3);Satisfied (4);Strongly Satisfied(5)

14 Availability of data sources used for BI

15 Usability of data sources used for BI

16 Ease of understanding of data sources used for BI

17 Conciseness of internal data sources used for BI

BI Maturity Level Section : Scale used - Strongly disagree (1);disagree (2);Neither agree nor disagree(3);Agree (4);Strongly Agree(5)

18 BI is financially supported/led by influential persons from business

19 Significant BI decisions are made by a BI steering committee within business

20 BI is based on a comprehensive BI strategy that is regularly updated

21 BI management is based on elaborated methods such as cost accounting, balanced scorecard or portfolio management

22 IT acts as a business partner and takes an active role in improving business practices on the basis of BI

BI organization and responsibilities are centralized inside the
23 enterprise
Standard reports and dashboards ensure a high quality
24 information supply
Advanced analytical requirements are addressed on the basis of
25 existing OLAP tools and software for pro-active analyses
BI Systems provides seamless access to information across
26 different systems
27 Information is integrated across departmental borders
28 Tools and applications
29 Business content, i.e. KPIs and dimensions
30 Management and sourcing processes
31 Development processes
32 Operations processes
33 Top management
34 Middle management
35 Analysts, data scientists
36 Operative users
Roles, tasks and responsibilities are clearly defined and
37 document in the context of data quality
Core business objects, performance indicators and dimensions
38 are consistently defined
Data quality is continuously measured in order to pro-actively
39 manage data quality
Operation of BI systems is based on defined service-level
40 agreements
41 State of the art BI frontends are used
Response times of BI systems enable efficient and effective
42 usage