



The Influence of Critical Success Factors on Business Intelligence Net Benefits

A dissertation presented to the

Department of Information Systems

University of Cape Town

in partial fulfilment of the requirements for the course on

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by

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Abstract

Background:

Business intelligence (BI) is regarded as a key practice to invest into and adopt. This is due to the benefits that can be realized from BI. Critical success factors (CSFs) need to be managed appropriately for organizations to realize maximum benefit from their BI investments.

Objective:

The objective of this study is to measure the influence of BI CSFs on BI net benefits. In addition, the interrelationships between these CSFs will be measured, the effect of moderating variables will be determined and the reasons why these CSFs are important will be explored.

Method:

A deductive approach was followed. A conceptual model was derived from literature. This model was used to construct an online survey. The data gathered from the survey was analysed using statistical techniques. The results from the statistical analysis were validated and expanded on by conducting semi-structured interviews with participants who completed the online survey.

Results:

The results found that top management support, alignment between BI and business objectives and BI technology fit for the business were determined to be the most influential BI CSFs to realize BI net benefits. Top management support was shown to have a relationship with all other CSFs. Well-defined user requirements and user participation did not have a relationship with BI net benefits. Industry and size moderated a small portion of the relationships between BI CSFs and BI net benefits.

Conclusion:

Organizations need to prioritize top management support, alignment between BI and business objectives, BI technology fit for the business, incremental project management methodology and adequate team skills, to realize BI net benefits. Special attention should be given to top management support as it influences all other BI CSFs.

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1 Introduction

Business intelligence (BI) is regarded as a top technology to implement and invest in globally (Luftman, et al., 2013). This is due to the various benefits that can be realized through BI (Işık, Jones, & Sidorova, 2013). Achieving BI success remains challenging for both academics and industry alike (Yeoh & Popovič, 2016). BI projects are still considered risky due to the high failure rate (Ravasan & Savojsi, 2014). Many BI projects are rejected by the business, partially used or regarded as unsatisfactory by the users (Yeoh & Popovič, 2016). The cause of this failure is due to organizations not identifying and managing the critical success factors (CSFs) that will influence BI success (Ravasan & Savojsi, 2014). Organizations still have a poor understanding of BI CSFs and the influence it has on BI success (Yeoh & Popovič, 2016).

Extensive studies have been done on identifying CSFs required for BI success (Bijker & Hart, 2013; Dawson & Van Belle, 2013). Studies on BI success and how it can be measured are also widely available (Mudzana & Maharaj, 2015). However, studies considering how CSFs influence BI success are scarce. The interrelationships between BI CSFs have not been explored. The reasons why CSFs are important for realizing BI net benefits are not well known. This study will aim to fill this gap in literature. The study will measure the influence of BI CSFs on BI success. The reasons why BI CSFs are important to realize BI net benefits will be explained. The aim of this paper is to fill this gap in literature. The primary objective will be to determine the influence of BI CSFs on BI success. The effect of moderating variables will also be measured as well as the interrelationships between the CSFs. This will be done through a quantitative study. The reasons why these CSFs are important will be determined through follow-up interviews with participants. Definitions for each CSF will be provided. The interviews will also provide a mechanism to validate the results found through the statistical analysis.

The paper will be structured as follows: Sections 2 to 7 will provide background information and context about BI. Sections 8 and 9 review previous studies on the topic and provide a list of the CSFs most prominently found in literature. The aim of sections 10 and 11 is to define BI success. Sections 12 and 13 explain the interrelationships between BI CSFs and moderating factors found in previous studies. The conceptual model, which indicates all the relationships that will be tested in this study, is derived in section 14. Each of the constructs indicated on the model is defined in section 15. Sections 16 to 20 are used to explain the current gap in literature, what the research problem is, how to break the problem up into research questions, the objectives that need to be achieved to answer the questions and the hypotheses that needs to be answered for this study. Section 21 states the methodology to be followed. The quantitative and qualitative analysis are conducted in sections 22 and 23. A discussion of the findings is presented in section 24. The paper concludes in section 25.

2 Overview of BI

BI is not just a technology. It is a combination of tools, techniques, processes, people and technology that assist organizations for decision-making purposes (Dawson & Van Belle, 2013). BI makes use of historical- and current data. This data is used to support management in making critical business decisions to improve organizational performance and efficiency (Işık, Jones, & Sidorova, 2013). BI enhances the ability to make rapid and more accurate decisions. It is used to make strategic, tactical and operational decisions. BI allows information users to receive information timeously and accurately (Mohamadina, Ghazali, Ibrahim, & Harbawi, 2012). BI enables organizations to transform raw data, which is not in actionable format, into meaningful facts of information that can be actioned. Organizations are able to make decisions based on the transformed data (Chaudhuri, Dayal, & Narasayya, 2011).

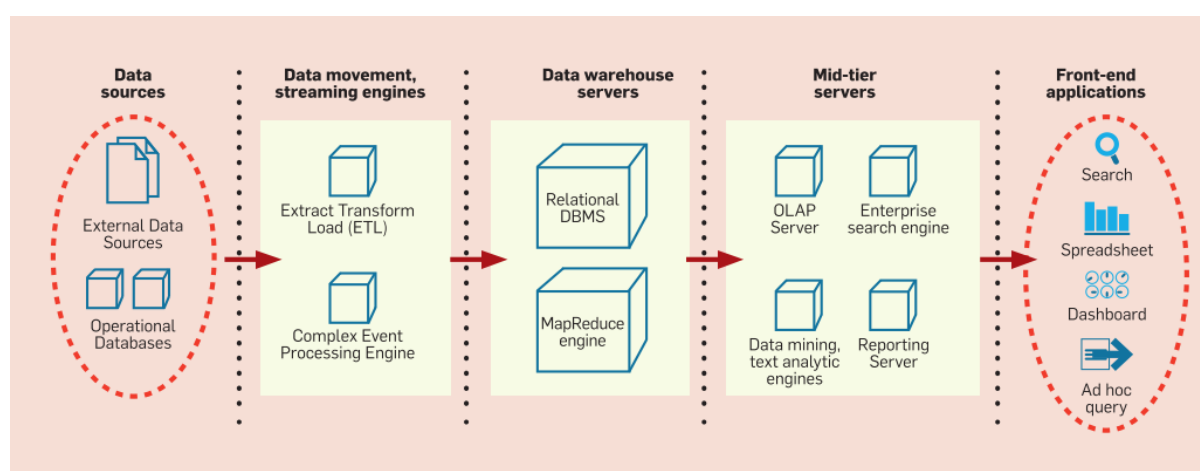


Figure 1: BI overview (Chaudhuri, Dayal, & Narasayya, 2011, p90)

Figure 1 provides an overview of the various BI components and the relationship between these components. Data is extracted from various data sources and in various formats. This data is transformed and cleaned through Extract-Transform-Load (ETL) processes. The transformed data is moved to the data warehouse. The data is then presented using multiple presentation tools which include online analytical processing (OLAP), spreadsheet technologies and visualization dashboards (Chaudhuri, Dayal, & Narasayya, 2011).

3 Perceived importance of BI

BI is regarded as one of the top practices to adopt within an organization. This has been recognized both by academics and practice alike (Chen, Chiang, & Storey, 2012). A survey conducted on thousands of information technology (IT) professionals across multiple industries and countries support this fact. The survey results published in the “IBM Tech Trends Report” in 2011 and shows BI rated as a top priority to adopt (Chen, Chiang, & Storey, 2012) by organizations. A Bloomberg Businessweek study shows that 97% of large organizations have adopted BI within their environments (Chen, Chiang, & Storey, 2012).

3.1 BI ranking compared to other technologies

A study conducted by Luftman et al. (2013) shows that BI has been rated as the top technology to invest in for over a decade in the United States of America (USA). The study shows that the trend is spreading to other continents. In Australia, Latin America and Europe, BI has been rated as the top technology since 2010 (Luftman, et al., 2013). Luftman et al. (2013) rank cloud computing, customer relationship management (CRM) and enterprise resource planning (ERP) as the other critical technologies to implement.

A study by Kappelman et al. (2013) agrees with the above results. The study shows that BI is ranked as the top technology organizations are investing into. A synergy exists between BI and the other technologies on the list (Kappelman, Luftman, Mclean, & Johnson, 2013). BI extracts data from systems such as ERP and CRM. There is thus a relationship between BI and these source systems.

This section provided insight on how BI is perceived as a technology to adopt within organizations. Many organizations have ranked BI as the top technology not just currently but over a long period of time. It is important to understand the factors that contribute to this ranking. The following section on BI components will provide more context to the perceived importance. It will describe how BI is used within practice.

4 BI components

4.1 ETL

ETL refers to the process of extracting data from various sources, transforming the data into more meaningful data and then loading the data into a data warehouse (Chaudhuri, Dayal, & Narasayya, 2011). ETL processes ensure that the data is of a high quality before being loaded into the data warehouse. To ensure data integrity, only high quality data should be loaded into the data warehouse (Chaudhuri, Dayal, & Narasayya, 2011). The data transformation logic is defined by the business and is commonly referred to as business rules (Watson, 2009).

ETL is also referred to as data integration within some organizations. In some instances the data is transformed after the loading process (Watson, 2009). This is known as ELT. ETL includes a process called data profiling (Chaudhuri, Dayal, & Narasayya, 2011). Data profiling is a process that identifies poor quality data and flags it for business users to fix. Data profiling further enhances the ability to load quality data into the data warehouse. ETL ensures that duplicate data is not loaded into the data warehouse (Chaudhuri, Dayal, & Narasayya, 2011). Duplication of data can cause incorrect results within dashboards and other reports. Decisions are then made based on incorrect views of data which could have financial repercussions.

4.2 Data warehouse

The data warehouse is a central storing location used to store all the data from the various sources. Data is loaded into the data warehouse through ETL processes (Chaudhuri, Dayal, &

Narasayya, 2011). This central storing location promotes the ability to make decisions based on a single version of the truth (Negash, 2004). Data mining, OLAP, data visualization and ad hoc reports are all executed from the data warehouse (Negash, 2004). The data warehouse integrates data from multiple disparate sources into a single structured and consistent environment (Tvrdivova, 2007). This enables organizations to make strategic, tactical and operational decisions.

4.3 OLAP

OLAP is a data delivery technique used for analytical purposes (Bogza & Zaharie, 2008). OLAP allows organizations to slice and dice multi-dimensional data (Ranjan, 2009). Dimensions include variables such as time, region, customer and sales agent. OLAP users are presented with summarized aggregated data to identify trends, opportunities and other factors that enable decision making (Ranjan, 2009). OLAP has filtering capabilities that allow users to filter on segments of data relevant to their business queries (Fisher, Drucker, & Czerwinski, 2014). In-memory abilities allow OLAP users to drill down into large datasets with increased performance and speed (Chaudhuri, Dayal, & Narasayya, 2011). OLAP is used to explore data and discover new business insights.

4.4 Data visualization

This technique promotes data discovery through graphical presentation of data (Ranjan, 2009). Visualization displays a large amount of information in aggregated views (Negash, 2004). These views allow users to make actionable decisions. Visualization attributes such as size, color, position, shape and pattern, allow organizations to identify trends quicker, spot anomalies within large datasets faster and identify relationships between data variables easier (Fisher, Drucker, & Czerwinski, 2014).

5 Skills required by BI professionals

BI professionals are resources that have experience in implementing BI and using BI technologies to add business value (Işik et al., 2013). BI projects require resources with specific skill sets. BI projects run the risk of failure if resources with these specific skills are not employed as part of the project (Clavier, Lotriet, & Van Loggerenberg, 2011). These resources need to be able to prepare the data for further analysis. They need to provide business insights on the data and manage their stakeholders. Strategic vision is required to link BI to the long term business objectives. BI professionals need to have a thorough understanding of the business processes and deliver sustainable code. They need to be able to transfer knowledge to other team members (De Jager & Brown, 2016).

6 BI project failure

BI project implementations often fail or are considered a failure (Olbrich, Poppelbuß, & Niehaves, 2012). The Cutter Consortium report (as cited in Olbrich et al., 2012) concluded that 41% of BI professionals have experienced BI project failure during their careers. There

are various reasons that contribute towards BI project failure. BI projects fail as the core focus of the project is not on meeting the customer or user requirements (Safeer & Zafar, 2011). There is a gap between the BI developers and users in terms of understanding the business requirements and -needs (Safeer & Zafar, 2011). Another reason for BI project failure is due to a lack of top management support and financial backing (Hostmann, 2007). The risk of BI project failure can be mitigated by defining and managing the critical success factors (CSFs) for BI success.

7 Critical success factors defined

Rockart (as cited in Olszak & Ziemba, 2012, p132.) defines CSFs as “the limited number of areas in which results, if satisfactory, will ensure successful competitive performance for the organization”. CSFs are not a set of tasks that should be followed. They are characteristics or variables that should be managed. These factors do not guarantee project success but rather increase the likelihood of project success (Ravasan & Savoji, 2014). Identifying and managing CSFs are crucial for achieving project success (Salehi Nasab et al., 2015; Dawson & Van Belle, 2013).

8 Previous studies conducted on BI CSFs

CSF frameworks are used by BI stakeholders to guide them in their BI projects to achieve project success (Mungree, Rudra, & Morien, 2013). Various CSF studies have been conducted. Some of these studies are described in Table 1. The table shows the authors that conducted the research, the year in which the paper was published, the country where the research was conducted and a short description of the study.

Table 1: Previous studies conducted

Author(s) and year	Country	Description
(Dawson & Van Belle, 2013)	South Africa	The purpose of the study was to rate BI implementation CSFs. A deductive approach was used. BI professionals were interviewed and asked to add CSFs to the framework presented to them. The framework was updated with the new CSFs. The CSFs were rated using the Delphi technique. The interviews were conducted within a single organization within three business units. The study took place in the financial services sector. The final results were compared to the results of a European study.
(Hartley & Seymour, 2015)	South Africa	The researchers conducted an inductive study. BI professionals within the public sector were interviewed. Thematic analysis was conducted to extract the various themes, i.e. the CSFs for BI implementation. Each of the CSFs were explained.
(Mungree, Rudra, & Morien, 2013)	Australia	This study followed a deductive approach. The researchers developed a CSF BI implementation framework by combining various CSF frameworks. A list of CSFs and their descriptions were derived. BI professionals were asked to rate each CSF. The researchers were able to add contextual elements to their CSF list by conducting semi-structured interviews with BI professionals.
(Olszak & Ziemba, 2012)	Poland	A CSF framework was developed by reviewing extant literature. The CSFs were grouped into three sections, i.e. organization, process and technology. Participants were asked if the CSFs had an impact on BI implementation success. The results were used to rate each CSF in terms of importance. The study thus followed a deductive approach.
(Papadopoulos & Kanellis, 2010)	Greece	A BI system was implemented at a bank in Greece. Once the implementation was completed the CSFs were determined. The research followed an inductive approach.
(Ravasan & Savoji, 2014)	Iran	A list CSFs were derived from a review of literature. The list contained twenty six CSFs. Twelve CSF frameworks were used to derive the list. The CSFs were grouped into higher level sections called components. These components were organizational, human resources, project management and technical.

Table 1: Previous studies conducted (continued)

Author(s) and year	Country	Description
(Salehi Nasab, Selamat, & Masrom, 2015)	Malaysia	A deductive study. Eight CSF frameworks were used to construct a CSF framework from existing literature. This resulted in a list of seventeen factors. A definition of each of the factors were provided. The Delphi technique was used to rate each CSF in terms of importance. One factor was removed from the list following the Delphi feedback.
(Yeoh, Koronios, & Gao, 2008)	Australia	This study used a single framework as guidance. The framework was a CSF list for data warehouse implementation. The authors argued that this framework is valid for the objective of this study. BI professionals were interviewed and asked to add to the CSF list. No factors were added. A Delphi technique was used to rate each CSF in terms of importance. The interviews also allowed the authors to add contextual elements to each CSF.
(Yeoh & Koronios, 2010)	Australia	A list of CSFs were constructed through interviews with BI professionals. A description of each factor was derived. The list was validated through five case studies.
(Yeoh & Popovič, 2016)	Australia	Seven case studies were performed using the Yeoh & Koronios (2010) study as a framework. The purpose of the study was to provide a better contextual understanding of BI CSFs. The study identified organizational factors as the most crucial factors. These factors should be prioritized above other factors.
(Wixom & Watson, 2001)	USA, South Africa, Canada, Austria	A research model for data warehouse success was developed from literature. A survey was then distributed asking respondents to add factors to the model. The updated model was used to conduct interviews with ten participants, who confirmed the validity of the model. The model was used for the quantitative study and survey questions were developed. In total 55 survey responses were received. The data was analyzed to measure the influence of the implementation factors on implementation- and system success.

9 Most prominent BI CSFs

A review of literature shows that the factors in Table 2 are prominent among various CSF studies. A common name was provided where authors are describing the same CSF but using different names. The list is sorted based on the frequency of the factors' occurrence in literature. The critical success factors and sources of literature are indicated in the table.

Table 2: CSFs for BI success

Critical success factor	References
Top management support	(Arnott, 2008)
	(Bijker & Hart, 2013)
	(Dawson & Van Belle, 2013)
	(Dinter, Schieder, & Gluchowski, 2001)
	(Hwang & Xu, 2007)
	(Mohamadina, Ghazali, Ibrahim, & Harbawi, 2012)
	(Mungree, Rudra, & Morien, 2013)
	(Olbrich, Poppelbuß, & Niehaves, 2012)
	(Olszak & Ziemba, 2012)
	(Papadopoulos & Kanellis, 2010)
	(Ravasan & Savoji, 2014)
	(Salehi Nasab, Selamat, & Masrom, 2015)
	(Sangar & Iahad, 2013)
	(Wixom & Watson, 2001)
	(Yeoh & Koronios, 2010)
	(Yeoh & Popovič, 2016)
(Yeoh, Koronios, & Gao, 2008)	
Data quality	(Arnott, 2008)
	(Bijker & Hart, 2013)
	(Dawson & Van Belle, 2013)
	(Foshay & Kuziemy, 2014)
	(Hwang & Xu, 2007)
	(Mohamadina, Ghazali, Ibrahim, & Harbawi, 2012)
	(Mungree, Rudra, & Morien, 2013)
	(Olbrich, Poppelbuß, & Niehaves, 2012)
	(Papadopoulos & Kanellis, 2010)
	(Ravasan & Savoji, 2014)
	(Salehi Nasab, Selamat, & Masrom, 2015)
	(Sangar & Iahad, 2013)
	(Wixom & Watson, 2001)
	(Yeoh & Koronios, 2010)
	(Yeoh & Popovič, 2016)
	(Yeoh, Koronios, & Gao, 2008)
Adequate resources	(Arnott, 2008)
	(Dawson & Van Belle, 2013)

Critical success factor	References
	(Dinter, Schieder, & Gluchowski, 2001) (Foshay & Kuziemy, 2014) (Hartley & Seymour, 2015) (Hwang & Xu, 2007) (Olbrich, Poppelbuß, & Niehaves, 2012) (Olszak & Ziemba, 2012) (Ravasan & Savoji, 2014) (Salehi Nasab, Selamat, & Masrom, 2015) (Wixom & Watson, 2001) (Yeoh & Koronios, 2010) (Yeoh & Popovič, 2016) (Yeoh, Koronios, & Gao, 2008)
Appropriate team skills	(Arnott, 2008) (Dinter, Schieder, & Gluchowski, 2001) (Foshay & Kuziemy, 2014) (Hartley & Seymour, 2015) (Hwang & Xu, 2007) (Mohamadina, Ghazali, Ibrahim, & Harbawi, 2012) (Mungree, Rudra, & Morien, 2013) (Olbrich, Poppelbuß, & Niehaves, 2012) (Olszak & Ziemba, 2012) (Salehi Nasab, Selamat, & Masrom, 2015) (Sangar & Iahad, 2013) (Wixom & Watson, 2001) (Yeoh & Koronios, 2010) (Yeoh & Popovič, 2016) (Yeoh, Koronios, & Gao, 2008)
BI technology fit for the business	(Arnott, 2008) (Hartley & Seymour, 2015) (Hwang & Xu, 2007) (Iffat, M, Ahmad, & Rabail, 2015) (Mohamadina, Ghazali, Ibrahim, & Harbawi, 2012) (Mungree, Rudra, & Morien, 2013) (Olszak & Ziemba, 2012) (Papadopoulos & Kanellis, 2010) (Ravasan & Savoji, 2014) (Salehi Nasab, Selamat, & Masrom, 2015) (Sangar & Iahad, 2013) (Wixom & Watson, 2001) (Yeoh & Koronios, 2010) (Yeoh & Popovič, 2016) (Yeoh, Koronios, & Gao, 2008)
Incremental project management methodology	(Arnott, 2008)

Critical success factor	References
	(Hwang & Xu, 2007) (Mohamadina, Ghazali, Ibrahim, & Harbawi, 2012) (Mungree, Rudra, & Morien, 2013) (Olbrich, Poppelbuß, & Niehaves, 2012) (Ravasan & Savoji, 2014) (Salehi Nasab, Selamat, & Masrom, 2015) (Sangar & Iahad, 2013) (Yeoh & Koronios, 2010) (Yeoh & Popovič, 2016) (Yeoh, Koronios, & Gao, 2008)
Align BI with business objectives	(Arnott, 2008) (Bijker & Hart, 2013) (Dinter, Schieder, & Gluchowski, 2001) (Hartley & Seymour, 2015) (Iffat, M, Ahmad, & Rabail, 2015) (Mungree, Rudra, & Morien, 2013) (Olbrich, Poppelbuß, & Niehaves, 2012) (Olszak & Ziemba, 2012) (Papadopoulos & Kanellis, 2010) (Ravasan & Savoji, 2014) (Salehi Nasab, Selamat, & Masrom, 2015)
Well defined business requirements	(Arnott, 2008) (Hwang & Xu, 2007) (Mungree, Rudra, & Morien, 2013) (Olszak & Ziemba, 2012) (Ravasan & Savoji, 2014) (Salehi Nasab, Selamat, & Masrom, 2015) (Sangar & Iahad, 2013) (Yeoh & Koronios, 2010) (Yeoh, Koronios, & Gao, 2008)
User participation	(Dawson & Van Belle, 2013) (Dinter, Schieder, & Gluchowski, 2001) (Hwang & Xu, 2007) (Mohamadina, Ghazali, Ibrahim, & Harbawi, 2012) (Olbrich, Poppelbuß, & Niehaves, 2012) (Ravasan & Savoji, 2014) (Salehi Nasab, Selamat, & Masrom, 2015) (Wixom & Watson, 2001)
Effective change management	(Bijker & Hart, 2013) (Dinter, Schieder, & Gluchowski, 2001) (Sangar & Iahad, 2013) (Yeoh & Koronios, 2010) (Yeoh & Popovič, 2016)

Critical success factor	References
	(Yeoh, Koronios, & Gao, 2008)

10 Success measurement models

10.1 Information system success models

One of the most prominently cited success models that measures information system (IS) success was developed by Delone and McLean in 1992 (Adamala & Cidrin, 2011). These authors subsequently updated the model in 2003 (Adamala & Cidrin, 2011). Figure 2 provides an example of the model. It shows the success criteria as defined by the authors to ultimately measure the net benefits of an IS implementation. The success criteria were identified as information quality, system quality, service quality, intention to use, user satisfaction and net benefits (Delone & Mclean, 2003).

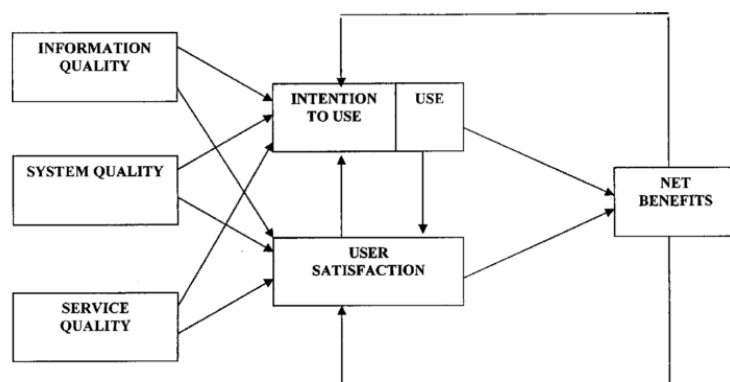


Figure 2: Delone and McLean IS success model (Delone & Mclean, 2003, p24)

10.2 Validation and extension of the Delone and McLean success model

The Delone and McLean (D&M) success model has been validated and extended over the years. The updated (2003) model was used to measure the success of a logistics tracking system by Green and Robb (2014). A quantitative study conducted by Wang and Liao (2008) validated the Delone and McLean success model for eGovernment systems. They used structural equation modelling to test the relationships between the six success criteria. The results show that the model is well-supported with strong relationships for all the links except for the link between system quality and system use (Wang & Liao, 2008).

10.3 Critique of the D&M success model

Green and Robb (2014) argue that the D&M model is not without its limitations. In their study they propose that business value, institutional trust and future readiness should be included as success variables as part of the model (Green & Robb, 2014). Mardiana, Tjakraatmadja and Aprianingsih (2015) argue that the Delone and McLean model on its own is not enough to measure IS success. The relationships between the IS success criteria are not significant (Mardiana et al., 2015) to justify that this model alone can measure IS succes. The model should be updated to integrate with the technology acceptance model (TAM) as well

as the unified theory of acceptance- and use of technology (UTAUT) model. The success criteria of TAM include perceived usefulness, perceived ease of use, attitude towards using, behavioral intention to use and system actual use (Mardiana et al., 2015).

10.4 BI success models

Section 10 thus far has focused on IS success criteria. This section will focus on BI specific success criteria which forms part of the bigger IS umbrella (Adamala & Cidrin, 2011). Işik et al. (2013) mention that BI success can be measured by the positive influence the BI system has on the organization. They argue that the success of BI differs by definition based on the organization that uses it. The success criteria is dependent on expected benefits of the system (Işik et al., 2013). The criteria include return on investment, perception of BI as a mission critical system for the organization as well as number of active users of the system (Işik et al., 2013).

A recent study by Yeoh and Popovič (2016) argues that BI success criteria should be split into infrastructure- and process criteria. Infrastructure criteria consists of system quality, information quality and system use (Yeoh & Popovič, 2016) thus excluding service quality and user satisfaction from the original Delone and McLean success criteria (Delone & Mclean, 2003). Process criteria refer to whether the project was done within budget and time specifications. This aligns to project success criteria included in the Iron triangle which is extensively used to measure project success (Atkinson, 1999). It could be argued that quality is excluded from the process criteria as system quality and information quality are already included in the infrastructure criteria. Figure 3 shows the BI success criteria as defined by Yeoh and Popovič (2016).

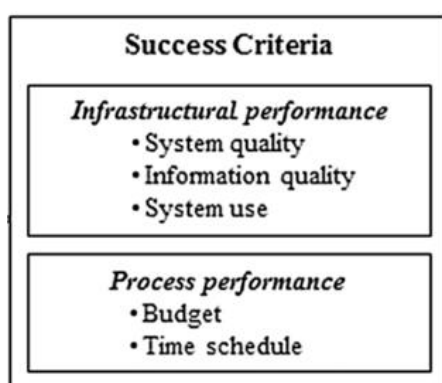


Figure 3: Yeoh and Popovic BI success criteria (Yeoh & Popovič, 2016, p3)

Mudzana and Maharaj (2015) used the updated Delone and McLean model of 2003 in their study to measure BI success within South Africa. Their study used quantitative statistical methods to measure the correlation between the six success criteria. The model was partially supported. The relationships that did not agree with the literature were between system quality and system use, information quality and user satisfaction, service quality and user satisfaction, as well as system use and net benefits (Mudzana & Maharaj, 2015). Popovič, Hackney, Coelho and Jaklič (2012) argue that BI is unique and should have different success

criteria to operational systems used for transactional processing. They included BI maturity and analytical decision-making culture within their success model (Popovič, Hackney, Coelho, & Jaklič, 2012). It can be argued that the latter refers to CSFs rather than success criteria used to measure BI success.

Table 3 provides a summary of the existing literature on BI success models.

Table 3: BI success models

Author(s) and year	Success criteria
(Yeoh & Koronios, 2010)	System quality, information quality, system use, budget, time schedule and perceived business benefit.
(Işik, Jones, & Sidorova, 2013)	Expected benefits, improved profitability, reduced cost and improved efficiency.
(Mudzana & Maharaj, 2015)	D&M success criteria for IS. Partially supported through quantitative data analysis.
(Popovič, Hackney, Coelho, & Jaklič, 2012)	BI maturity, information content quality, information access quality, analytical decision making culture and use of information in business processes.
(Wixom & Watson, 2001)	Perceived net benefits: (1) Less time and effort to support decision makers and business resources. (2) Job functions are changed in a positive manner.
(Peters, Popovic, Isik, & Weigand, 2014)	Accessibility, interface design, ease of use, flexibility, information quality, use, user satisfaction and net benefits.
(Kulkarni & Robles-Flores, 2013)	Net benefits (improved performance, increased productivity, enhanced effectiveness) and user satisfaction (information is easier to find, information needs are satisfied, user needs are satisfied).
(Schieder & Gluchowski, 2011)	D&M criteria plus functional coverage, technical suitability and organizational maturity.

11 CSFs BI success criteria models

11.1 Wixom and Watson DW success model

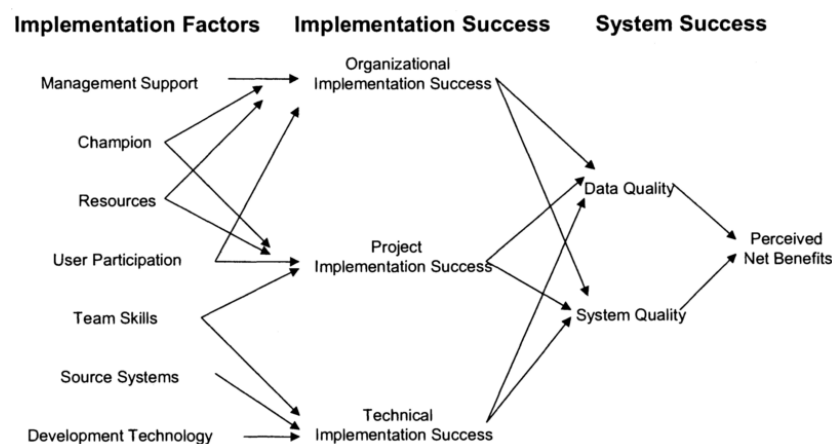


Figure 4: Wixom and Watson DW success model (Wixom & Watson, 2001, p20)

Figure 4 shows the data warehouse (DW) success model developed by Wixom and Watson in their 2001 study. As indicated in section 4.2, the DW is a component which forms part of BI (Schieder & Gluchowski, 2011). The model shows the relationships between the CSFs and BI success criteria. The model splits success into implementation- and system success.

Organization implementation success is achieved when the business users accept the solution that was implemented and integrates the system into their operational business processes (Wixom & Watson, 2001). This definition aligns to the user satisfaction criteria of the D&M model (Delone & Mclean, 2003). Project implementation success refers to the project team. This includes the skills the team possess as well as the ability of the team to deliver projects within time, cost and scope. The DW needs to integrate information from disparate systems into a consistent format. High volume data storage should be managed. These are considered technical implementation success criteria (Wixom & Watson, 2001).

Hawking and Sellitto (2010) critiques the model and argue that it does not include strategic factors that will influence the success of the BI system. Business and BI alignment, clear business objectives and the appropriate project methodology should be included in the model (Hawking & Sellitto, 2010). The criteria align to that of the D&M model. The Wixom and Watson model is only partially supported (Schieder & Gluchowski, 2011). The results show that not all the relationships in the model are sufficient (Wixom & Watson, 2001). It should be noted that the majority of the CSFs as well as the success criteria are generic for IS and not BI specific (Wixom & Watson, 2001).

11.2 Yeoh and Popovič BI CSF model

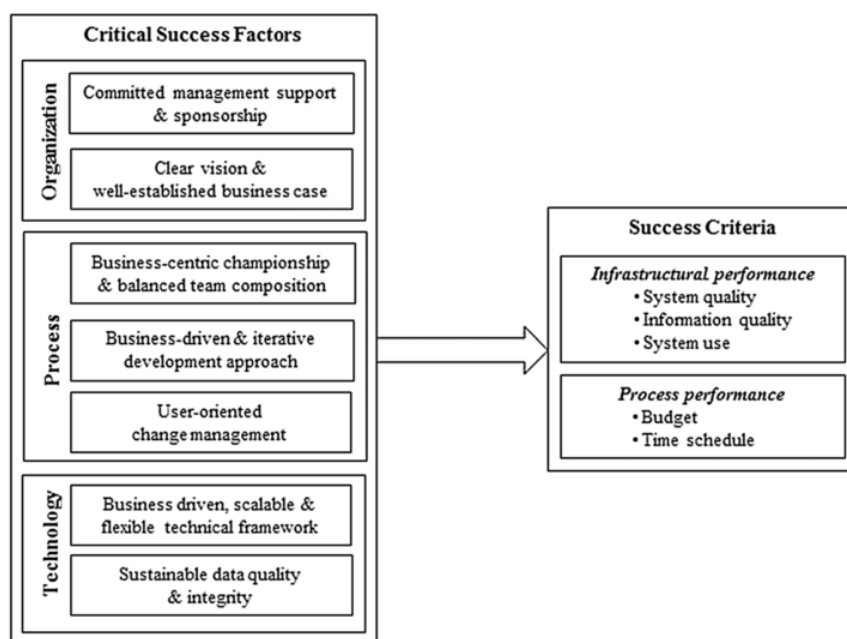


Figure 5: Yeoh & Popovič BI CSF model (Yeoh & Popovič, 2016, p136)

The Yeoh and Popovič (2016) model combines the CSF model developed by Yeoh and Koronios in 2010 with the D&M success model and the Iron triangle success criteria used to measure BI success. This model is shown in Figure 5. The CSFs are grouped into organization, process and technology factors (Yeoh & Popovič, 2016). Organizational factors include defining a business case and having top management support. Process factors relate to sufficient team skills, the project management methodology employed and how change is managed. The quality and integrity of the data as well as the flexibility and scalability of the BI system are considered technology factors.

The qualitative study conducted by Yeoh and Popovič (2016) concluded that managing the CSFs is essential for BI success. The organizational factors were highlighted as the highest priority CSFs (Yeoh & Popovič, 2016). Organizations should ensure that they have established a comprehensive business case and have the full support from management and executives before undertaking any BI project. There is a strong correlation between the Yeoh and Popovič (2016) model and the Wixom and Watson (2001) model. The CSFs and criteria used to measure BI success show a high match rate when comparing the models.

12 Interrelationships between CSFs

No literature could be found which indicates the interrelationships between the BI CSFs. However, various studies have implicitly implied that those relationships exist. Table 4 provides a list of extracts from literature which indicates that interrelationships between BI CSFs exist. The table indicates the interrelationships, the extracts that support the interrelationship and the references where the extracts can be found.

Table 4: Interrelationships in literature

Interrelationship	Reference	Extract from literature
A high level of top management support is associated with a high level of adequate resources.	(Yeoh & Koronios, 2010, p. 26)	“All Delphi participants agreed that consistent support and sponsorship from business executives make it easier to secure the necessary operating resources such as funding, human skills, and other requirements.”
	(Wixom & Watson, 2001, p. 23)	“Management support is widespread sponsorship for a project...”
A high level of top management support is associated with a high level of effective change management.	(Wixom & Watson, 2001, p. 23)	“It motivates people in the organization to support the data warehousing initiative and the organizational changes that inevitably accompany it.”
	(Yeoh & Koronios, 2010, p. 26)	“...commitment and involvement of senior management is imperative, particularly in breaking down the barriers to change...”
A high level of top management support is associated with a high level of user participation.	(Wixom & Watson, 2001, p. 23)	“...encourage participation throughout the organization...”
A high level of top management support is associated with a high alignment between BI and the business objectives.	(Yeoh & Popovič, 2016, p. 140)	“Hence, senior managers together with the committees could determine a strategic BI governance direction and ensure that the process for establishing and maintaining the BI-business alignment would be ongoing.”
A high level of adequate resources is associated with high levels of appropriate team skills.	(Wixom & Watson, 2001, p. 23)	“Resources include the money, <i>people</i> , and time...”

Interrelationship	Reference	Extract from literature
A high level of effective change management is associated with a high level of user participation.	(Wixom & Watson, 2001, p. 21)	<p>“...effectively address issues that result from change...”</p> <p>“...encourage people throughout the organization to embrace data warehousing...”</p>

Table 5: Moderator variables

Reference	Moderator(s)
(Yeoh, Koronios, & Gao, 2008)	Role; Organization type; BI system; Industry
(Foshay & Kuziemy, 2014)	Role; Years of experience
(Olszak & Ziemba, 2012)	Size of organization

13 Moderators

No BI quantitative literature was found which included moderator variables as part of studies. Qualitative studies however have included moderator variables as part of their studies. These moderator variables were taken into account when writing up the results and findings for the various studies. Table 5 indicates these moderating variables. The references to where each moderator can be found is also indicated. The following moderating variables was used within the conceptual model: Role, size of organization, industry and years of experience.

A previous non-BI study have included company size and industry as moderating factors (Marín, Rubio, & Maya, 2012). This study measured the influence of corporate social responsibility (independent variable) on organization competitiveness (dependent variable), i.e. the success of the organization compared to its competitors. This study will follow a similar approach as the study by Marín, Rubio and Maya (2012) by including company size and industry type as moderating factors.

14 Conceptual model

Figure 6 shows the conceptual model that will be used for this research. The CSFs were derived by reviewing existing literature. Only the top ten most prominent CSFs were included in the conceptual model. A detailed list of CSFs and their source of literature can be found in Section 9. Net benefits were selected as the construct to measure BI success for the following reasons: The D&M IS success model is a widely used and accepted model to measure IS success. This model uses net benefits as the final dependent variable. The model has been used extensively within previous literature to measure BI success (Yeoh & Koronios, 2010; Işık, Jones, & Sidorova, 2013; Mudzana & Maharaj, 2015; Wixom & Watson, 2001; Peters, Popovic, Isik, & Weigand, 2014; Kulkarni & Robles-Flores, 2013; Schieder & Gluchowski, 2011).

The model also groups BI CSFs into organizational, process and technology CSFs. The groupings are aligned to the Yeoh & Popovič (2016) model groupings. The conceptual model indicates the interrelationships between the BI CSFs as discussed in section 12. Industry, organization size, role and experience were added as moderating variables to the conceptual

model as per section 13.

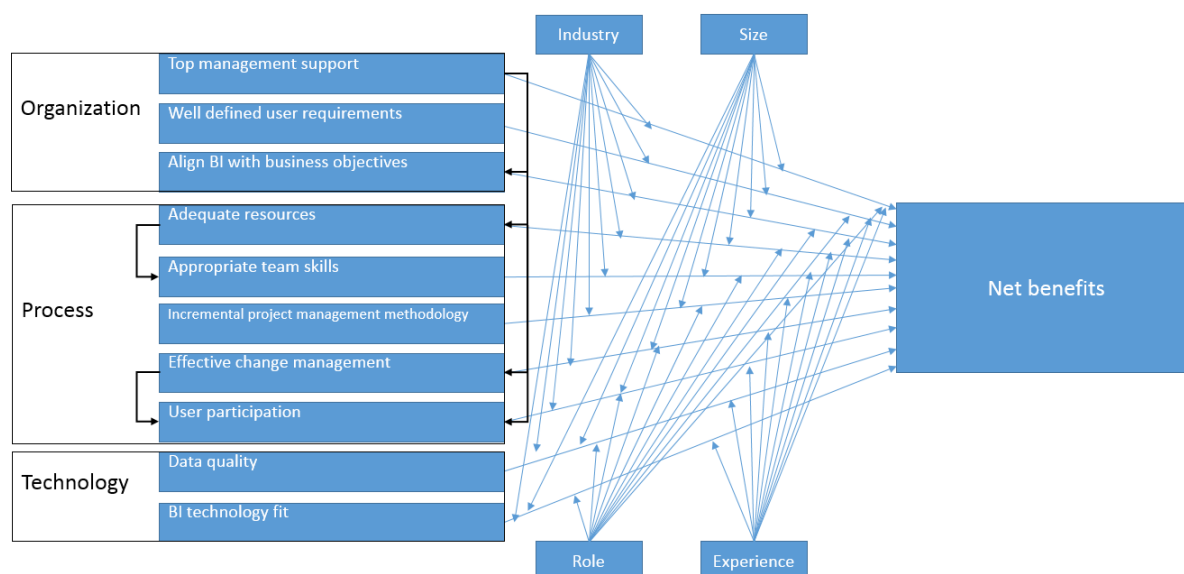


Figure 6: CSFs BI success conceptual model

15 CSFs and BI success defined

Organizational factors

15.1 Top management support

This CSF is regarded as the most important factor to manage for ensuring BI project success (Yeoh & Koronios, 2010; Salehi Nasab et al., 2015). Management provides access to human resources and additional funding and sponsorship (Yeoh & Koronios, 2010; Mungree et al., 2013). Through the support structure, management is able to minimize resistance by business users (Ravasan & Savoji, 2014). This includes internal organizational politics that can cause project failure (Salehi Nasab et al., 2015). Having management support increases the likelihood of organizational buy-in as management encourages the use of BI (Yeoh et al., 2008). Top management should encourage hiring and retaining top BI talent (Kulkarni & Robles-Flores, 2013).

15.2 Well defined business requirements

The business requirements need to align to the long term strategic vision of the organization (Yeoh & Koronios, 2010). This will increase the level of management support and commitment (Yeoh et al., 2008). The requirements need to be business driven rather than IT driven (Yeoh & Koronios, 2010). The business requirements, which should be thoroughly documented, and project deliverables need to align to the user expectations (Mungree et al., 2013). These requirements need to be well understood and accepted by all stakeholders before BI projects commence (Arnott, 2008).

15.3 Align BI with business objectives

BI projects should have a link to the corporate strategies (Arnott, 2008). The projects undertaken should be economically feasible and justified through the business benefits. BI strategy should always align to the broader corporate strategy as set by executives and senior management (Bijker & Hart, 2013).

Process factors

15.4 Adequate resources

Adequate resources are provided through top management support and sponsorship (Yeoh, Koronios, & Gao, 2008). This includes the funding of software, hardware and human resources required to complete BI projects (Mungree, Rudra, & Morien, 2013). Dedicated resources are required on BI projects (Salehi Nasab, Selamat, & Masrom, 2015). The need for these resources should be established before the project commences. Failure to obtain resources can result in project failure. The BI team has to be provided with sufficient time, which is considered a resource, to complete their tasks (Wixom & Watson, 2001).

15.5 Appropriate team skills

The BI project team needs to have sufficient technical skills, soft skills and business knowledge to manage their BI projects and complete their tasks (Salehi Nasab, Selamat, & Masrom, 2015). The team needs to be cross-functional (Yeoh, Koronios, & Gao, 2008). There is a shortage of BI skills within South Africa (Hartley & Seymour, 2015). Maximum business benefit is not derived from BI tools due to this skill shortage. Appropriate training is required to bridge the skills gap.

15.6 Incremental project management methodology

The BI project should follow an incremental delivery approach. Large-scale change increases the risk of project failure as multiple tasks need to be managed simultaneously (Yeoh et al., 2008). An iterative approach allows the project team to show constant progress which impacts business buy-in (Yeoh et al., 2008). This approach also speeds up delivery time (Salehi Nasab et al., 2015). The scope of the project needs to be clearly defined. The objectives need to be realistic and achievable (Mungree et al., 2013). The scope of the project needs to be determined prior to the start date (Yeoh & Koronios, 2010).

15.7 Effective change management

Users need to be involved in the change management process. This will insure that their needs and requirements are better communicated (Yeoh & Koronios, 2010). Consistent user involvement during the lifecycle of the project increases the likelihood of system usage (Salehi Nasab et al., 2015). Business users understand their own needs better than BI architects and developers which is why their input is crucial during the change management process (Yeoh et al., 2008). Sufficient time and resources need to be spent on training and support as part of the change management process (Mungree et al., 2013).

15.8 User participation

Users should be involved during the entire BI project lifecycle (Salehi Nasab et al., 2015). Users are often assigned tasks which form part of the BI delivery (Yeoh & Koronios, 2010). The BI team and end-users work together on BI projects (Wixom & Watson, 2001). This increases the likelihood of user acceptance once the project has been completed. User expectations and requirements are also met more often with increased user participation. When users are involved during the project they obtain a better understanding of what the end product or solution will deliver (Wixom & Watson, 2001). This makes users more likely to accept the solution once delivered.

Technology factors

15.9 Data quality

Data quality and integrity need to be managed at the source (Yeoh et al., 2008). An appropriate data governance process needs to be established. This includes a data governance committee responsible for developing the procedures and execution plans (Yeoh et al., 2008). Poor data quality will lead to inaccurate decision making (Salehi Nasab et al., 2015). ETL processes should ensure that only quality data is loaded into the data warehouse (Mungree et al., 2013). The extent to which data needs to be transformed before being loaded into the data warehouse has an impact on the data quality (Wixom & Watson, 2001). The number of diverse and heterogeneous source systems impact the quality of the data. An enterprise resource planning (ERP) system which integrates various system functions, increases data quality and integrity (Ravasan & Savoji, 2014). A list of definitions for fields within the data warehouse has an impact on data quality. This makes the purpose of the data more understandable to users (Yeoh & Popovič, 2016).

15.10 BI technology fit for the business

The BI system needs to be scalable and flexible to adapt to the ever-changing business processes and requirements (Yeoh & Koronios, 2010). The BI system should be able to accommodate additional data sources and changes to data attributes (Yeoh & Koronios, 2010). Additional business processes will lead to a growth in data to be processed by the BI system. The system should be able to accommodate this growth in data without impacting the performance of the system drastically (Salehi Nasab et al., 2015). The BI technology should be a proper fit for the existing environment (Wixom & Watson, 2001).

Dependent variable

15.11 Net benefits

BI enables strategic decision making. Organizations gain a competitive advantage by implementing BI (Ranjan, 2009). Organizations are able to make future predictions to increase profits or mitigate possible risks by making use of BI (Ranjan, 2009). BI provides a

method to extract meaning out of data. Organizations are able to identify patterns within large datasets, identify relationships between variables, spot anomalies and potential trends (Muntean, Bologna, Bologna, & Florea, 2011). The primary benefits provided by BI will be mentioned and described below.

15.11.1 Enhanced decision making capabilities

Organizations are able to analyze customer data. This information can be used to make decisions on which customer segments to target, potentially leading to increased profit (Ranjan, 2009). Organizations can formulate strategies to retain and grow their customer base by analyzing their customer data. Organizations are able to extract, analyze and distribute data (Hedgebeth, 2007).

Decisions can be made based on facts rather than gut feel or intuition. Data-driven decisions are made through the use of BI (Fisher, Drucker, & Czerwinski, 2014). Informed business decisions are made on actionable data (Hedgebeth, 2007). Real-time information allows organizations to make decisions and take action as an event happens (Golfarelli, Rizzi, & Cella, 2004). BI thus does not only improve the quality of the decisions but also reduces the time it takes to make business critical decisions (Rouhani, Ashrafi, Ravasan, & Afshari, 2016). Faulty or incorrect processes can be identified and fixed which could lead to cost savings. Enhanced decision making as a benefit of BI is not always easy to measure (Watson, 2009).

15.11.2 Planning, forecasting and predicting

Past and present data is used within statistical models for planning purposes. Future scenarios are forecasted, allowing the organization to implement strategic plans (Ranjan, 2009). Planning and forecasting are not only applicable to strategic decision making. Tactical and operational decision-making capabilities are also improved by using these techniques (Negash, 2004). Negash (2004) mentions that forecasting is critical for the marketing department of an organization. Organizations are able to analyze past and current promotion data to predict the future value of promotions. The forecasted results can be used to adjust current promotion policies and gain maximum value from promotions.

Organizations that aim to gain a competitive advantage should make use of forecasting and predictive modelling (Bogza & Zaharie, 2008). Forecasting resorts within the field of advanced analytics within the larger BI umbrella (Dobrev & Hart, 2015). A combination of historic and current data is used to predict future patterns. Data quality is pivotal when doing predictions (Hedgebeth, 2007). Inaccurate data can lead to incorrect results being used for decision making. This can have an adverse financial impact on the business.

15.11.3 On-demand decision making abilities

Data visualization allows organizations to make on-demand decisions based on aggregated views of data (Chaudhuri, Dayal, & Narasayya, 2011). Rather than sifting through- and

analyzing vast amounts of information, organizations are able to look at graphical representation of information. This speeds up the process of making decisions. Through the use of data visualization, organizations are able to identify patterns, relationships and outliers within large datasets (Nasri, 2011). Mobile BI provides the ability to view BI dashboards on the-go (Işık, Jones, & Sidorova, 2013). Organizations are able to make decisions on-demand using devices such as mobile phones or tablets, without any constraints resulting from their location. Real-time decision making increases the ability to reduce costs and improve business processes (Rouhani et al., 2016).

16 Gaps in literature

BI CSFs have received extensive research attention (Arnott, 2008; Bijker & Hart, 2013; Dawson & Van Belle, 2013; Mungree, Rudra, & Morien, 2013; Olbrich, Poppelbuß, & Niehaves, 2012; Ravasan & Savojo, 2014). However, the influence of CSFs on BI success has received limited research focus.

Wixom and Watson (2001) measured the contribution of CSFs on data warehouse (DW) success criteria using quantitative analysis techniques. The study, however, does not gauge the influence of CSFs on net benefits directly. Additional layers between the CSFs and net benefits are present in their study. Their study does not focus on the interrelationships between the CSFs nor does it explain why the CSFs are important to realize BI net benefits. Yeoh and Popovič (2016) conducted a qualitative study to determine which of the CSFs have the greatest impact on BI success. Their study focused on providing a contextual understanding of the CSFs required for BI success. None of the South African studies measure the influence of CSFs on BI success using quantitative methods or measures the interrelationships between the factors (Dawson & Van Belle, 2013; Hartley & Seymour, 2015; Mudzana & Maharaj, 2015).

An extensive literature review revealed that limited studies have been conducted measuring the interrelationships of BI CSFs. Furthermore, limited studies have measured and explained the influence of CSFs on BI success (net benefits). Quantitative studies which include moderating variables as part of their conceptual model could not be found. There is thus a gap in the literature for the following study: The study needs to explain why CSFs are important to realize BI net benefits. The study should measure the interrelationships between BI CSFs. The influence of CSFs on net benefits should be measured. The effect of moderating variables on the relationship between BI CSFs and BI net benefits should be tested. This study aims to fill this gap in literature.

17 Research problem

Existing literature focus on the CSFs required for BI success. These CSFs have been well-defined in previous literature. The influence of CSFs on BI success is not well-known. The interrelationships between CSFs for BI success have not been explored at all in previous studies. Little is documented about the reasons why CSFs are important to realize BI success.

The effect of moderating variables on the relationship between BI CSFs and BI net benefits have not been measured.

18 Research question

The primary research question is:

- What is the influence of BI CSFs on BI net benefits?

The secondary research questions are:

- Why are BI CSFs important to realize BI net benefits?
- What are the interrelationships between BI CSFs?
- How does moderating variables affect the relationship between BI CSFs and BI net benefits?

19 Research objective

The following objectives needed to be achieved in order to answer the primary and secondary research questions:

1. A conceptual model was developed from existing literature. This model indicated the BI CSFs, its relationships to BI net benefits, the relationships between CSFs and the moderating variables that affect the relationships.
2. A quantitative study to measure the influence of BI CSFs on BI net benefits was conducted.
3. The interrelationships between the BI CSFs were measured.
4. The effect that the moderating variables had on the relationship between BI CSFs and BI net benefits were measured.
5. The reasons why BI CSFs are important to realize BI net benefits was determined.

20 Hypotheses

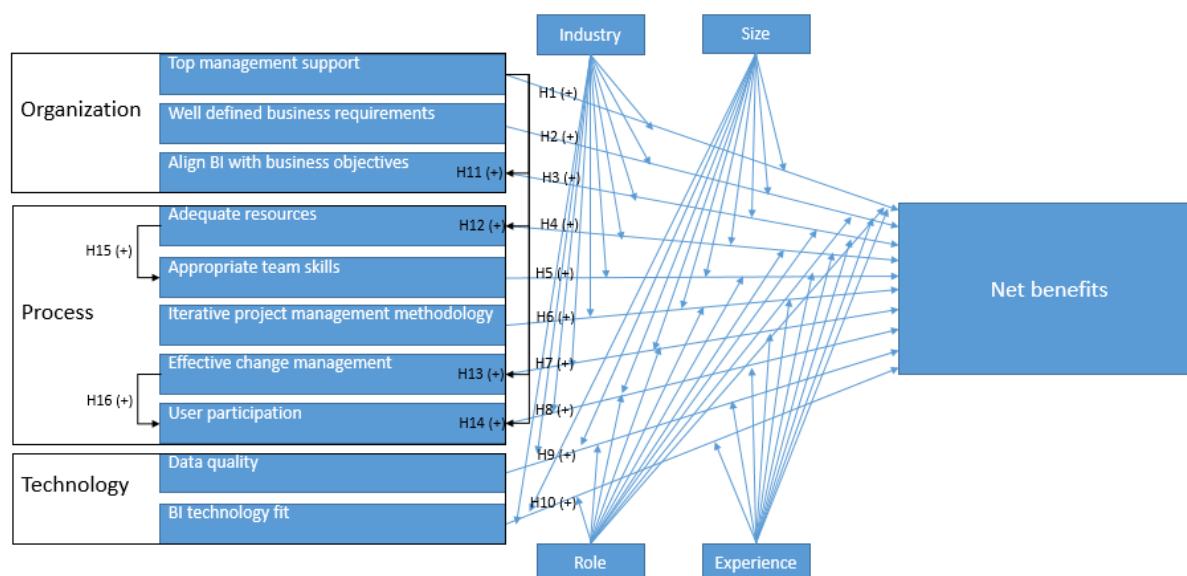


Figure 7: Hypotheses

Figure 7 shows the hypotheses derived from the literature review. The following hypotheses was tested for the purposes of this study:

H₁: A high level of top management support is associated with a high level of realized BI net benefits and is moderated by industry, size, role and experience.

H₂: A high level of well-defined business requirements is associated with a high level of realized BI net benefits and is moderated by industry, size, role and experience.

H₃: A high level of alignment between BI and the business objectives is associated with a high level of realized BI net benefits and is moderated by industry, size, role and experience.

H₄: A high level of adequate resources is associated with a high level of realized BI net benefits and is moderated by industry, size, role and experience.

H₅: A high level of appropriate team skills is associated with a high level of realized BI net benefits and is moderated by industry, size, role and experience.

H₆: A high level of incremental project management methodology is associated with a high level of realized BI net benefits and is moderated by industry, size, role and experience.

H₇: A high level of effective change management is associated with a high level of realized BI net benefits and is moderated by industry, size, role and experience.

H₈: A high level of user participation is associated with a high level of realized BI net benefits and is moderated by industry, size, role and experience.

H₉: A high level of data quality is associated with a high level of realized BI net benefits and is moderated by industry, size, role and experience.

H₁₀: A high level of BI technology fit for the business is associated with a high level of realized BI net benefits and is moderated by industry, size, role and experience.

H₁₁: A high level of top management support is associated with a high level of alignment between BI and the business objectives.

H₁₂: A high level of top management support is associated with a high level of adequate resources.

H₁₃: A high level of top management support is associated with a high level of effective change management.

H₁₄: A high level of top management support is associated with a high level of user participation.

H₁₅: A high level of adequate resources is associated with a high level of appropriate team skills.

H₁₆: A high level of effective change management is associated with a high level of user participation.

21 Research method

21.1 Ontology

Ontology can be defined as “our assumption about how we see the world” (Bhattacharjee, 2012, p. 21). This could be either that the world is in social order or that it is constantly changing (Bhattacharjee, 2012). Ontology is about how reality is perceived by the social actors (Saunders, Lewis, & Thornhill, 2009). There are two aspects of ontology, namely objectivism and subjectivism (Saunders, Lewis, & Thornhill, 2009).

Objectivism refers to the position that reality is not dependent on social actors and that it exists outside of the human consciousness (Tsang, 2013; Saunders, Lewis, & Thornhill, 2009). The subjectivism aspect holds the position that social phenomena are constructed from the way that social actors perceive the world and how their actions influence and impact the world (Bhattacharjee, 2012; Saunders, Lewis, & Thornhill, 2009). Venkatesh et al. (2013) claim that a researcher can have multiple worldviews. A mixed method approach can thus have aspects of both an objective and subjective stance (Venkatesh, Brown, & Bala, 2013).

This study is objective. Data was gathered and analyzed with an objective worldview. The analysis was not influenced by the social actors that partook in the study. The stance taken is that the phenomena exist outside of the reality of the social actors.

21.2 Epistemology

The epistemological stance taken will dictate the way the data is gathered as well as the methods used to interpret and analyze the data (Saunders, Lewis, & Thornhill, 2009). This helps to clarify the source of where evidence or data should be gathered, how such data should be interpreted as well as how the research question posed should be answered (Crossan, 2003). Researchers are able to save time as the epistemology helps with selecting the appropriate research method thereby avoiding unnecessary work to be undertaken (Crossan, 2003). Crossan (2003) claims that the epistemology aids the researcher in being more innovative and creative in his research. There are various epistemological paradigms which include positivist, interpretivist, critical research and pragmatist (Myers & Klein, 2011; Venkatesh et al., 2013).

Interpretivism helps researchers to gain an understanding of human thoughts and their actions (Klein & Myers, 1999). This paradigm aids in providing deep insight into the phenomena

being investigated (Klein & Myers, 1999). Interpretivism is used to describe, explain and explore the current situations and evidence being studied (Myers & Klein, 2011). An interpretivist approach means that the researcher and research subjects should have a common understanding of the topic being researched (Saunders, Lewis, & Thornhill, 2009). The researcher needs to understand those being studied in terms of how they view the world (Saunders, Lewis, & Thornhill, 2009). Critical research have additional elements not addressed by interpretivist research. This includes critiquing the status quo as well as making suggestions for improvement to the social environment (Myers & Klein, 2011).

Positivist paradigm is of the belief that the world and phenomena within it are objective (Straub, Boudreau, & Gefen, 2004). Data and truth is out there and available to be discovered (Straub, Boudreau, & Gefen, 2004). In positivist research the researcher is external from the observations being studied (Saunders, Lewis, & Thornhill, 2009). This implies that the researcher is objective and independent of the social actors (Saunders, Lewis, & Thornhill, 2009). Pragmatism is of the view that the research question should guide researchers in their selected methods (Venkatesh et al., 2013). This philosophical stance can move back and forth between an inductive and deductive approach (Saunders et al., 2009). Research of this nature usually applies mixed methods using both qualitative and quantitative methods within the study.

This study took a pragmatic philosophical stance. The research question guided the methods used throughout the study. The study moved from quantitative (measuring the influence of CSFs on BI net benefits and the interrelationships between the CSFs) to qualitative (determining the reasons why CSFs are important to realize BI net benefits and gaining a deeper understanding of the results obtained through the quantitative study).

21.3 Purpose

The research purpose can be classified into three groups. These groups are exploratory, descriptive and explanatory (Saunders, Lewis, & Thornhill, 2009). Exploratory research is usually conducted in areas that have not been researched extensively (Bhattacharjee, 2012). This research approach is used to provide scope to the research extent and to formulate thoughts or hypotheses about the phenomena being studied (Bhattacharjee, 2012).

Descriptive research provides low levels of interpretation of the data gathered (Vaismoradi, Turunen, & Bondas, 2013). This research method is used to paint a clear picture of the current phenomena being studied (Saunders, Lewis, & Thornhill, 2009). The primary purpose of this method is to describe the details of the observations being studied (Bhattacharjee, 2012; Baxter & Jack, 2008). Explanatory studies aim to describe the relationships and patterns of the studied observations (Saunders, Lewis, & Thornhill, 2009). This method explains why certain phenomena occur and explores additional factors not covered by descriptive research (Bhattacharjee, 2012).

This research is both descriptive and explanatory. The study describes the influence of CSFs on BI net benefits as well as the interrelationships between the CSFs. Explanations were provided for the reasons why CSFs are important to realize BI net benefits.

21.4 Approach

A deductive approach is followed when a theory, assumption or hypothesis is tested and validated against the research findings (Bhattacharjee, 2012; Thomas, 2006). The theory can be updated once it has been tested against the results of the research conducted (Saunders, Lewis, & Thornhill, 2009). During inductive research a theory is constructed from the phenomena being studied (Vaismoradi, Turunen, & Bondas, 2013). The theory is derived once the data gathered has been interpreted (Thomas, 2006).

This study is deductive. A conceptual model was developed from existing literature. This model shows the most prominent BI CSFs and the relationships they have with BI net benefits. This model was used to measure the influence of BI CSFs on BI net benefits. The interrelationships between the BI CSFs were also measured and the effect of the moderating variables were determined. Additional CSFs were not added to the conceptual model. The study was thus not inductive in nature.

21.5 Strategy

A conceptual model was developed. Extant literature was used to develop the model. The model indicates the CSFs (independent variables) and their relationship to BI net benefits (dependent variable). Data was gathered through an online survey. The data was analyzed using statistical methods such as correlation- and regression analysis. The results were used as input to conduct semi-structured interviews with BI professionals who took part in the survey. This was done to explain the reasons why the CSFs are important to realize BI net benefits and to validate the results from the statistical tests conducted.

This research used multiple methods (i.e. quantitative and qualitative) to study the same phenomena. This is known as triangulation (Pansiri, 2005). Triangulation is used to validate the results from the quantitative study and to gain a richer, more in-depth understanding of the results (Olsen, 2004). Various types of triangulation exist. This study uses data triangulation as a variety of sources are used to collect data for the study (Johnson, Onwuegbuzie, & Turner, 2007).

Venkatesh et al. (2013) argue that a mixed method approach can be used for seven different purposes. Confirmation is the mixed method purpose for this study. A qualitative study was conducted to confirm the results of the quantitative study. A similar approach was followed by Bhattacharjee and Premkumar (as cited in Venkatesh et al., 2013, p26.) in their 2004 study. Semi-structured interviews were conducted to compliment the results achieved through the statistical analysis completed (Venkatesh, Brown, & Sullivan, 2016).

21.6 Timeframe

Cross-sectional studies are studies undertaken at a single point in time (Saunders, Lewis, & Thornhill, 2009). These studies could be conducted using surveys or through interviews (Saunders, Lewis, & Thornhill, 2009). Longitudinal studies are conducted over a long period of time. The purpose of these studies is to determine how phenomena changes over time (Venkatesh et al., 2013). A cross-sectional study was conducted for this research project. Data was gathered and analysed at a single point-in-time over a two month period.

21.7 Instrument

Structured interviews have predefined interview questions (Saunders, Lewis, & Thornhill, 2009). The researcher does not deviate from the predefined questions. Semi-structured interviews are based on a list of themes (Saunders, Lewis, & Thornhill, 2009). Although a set of questions are prepared the researcher is able to deviate from those questions depending on the context of the interview and feedback received from the participants.

An online survey is a method that is generally faster than other methods to gather data (Fricker & Schonlau, 2002). Research shows that response rates of online surveys align to that of traditional methods such as mail (Ilieva, Baron, & Healey, 2002). This method can be cheaper and more cost-effective than other methods if used properly (Fricker & Schonlau, 2002).

This study made use of an online survey to gather data, with Qualtrics being used as the online survey tool. Semi-structured interviews were conducted after the survey results were analysed. This allowed the researcher to deviate from the questions based on the feedback received and add to the richness of the collected data.

The research questions for this study are based on existing literature as per section 15. Section 15 clearly defines each construct with references to literature. Table 6 shows how the definitions as per section 15 were operationalized into measures. The Likert scale will be used for each measure. Values on this scale range from “Strongly disagree” to “Strongly agree” (Bhattacharjee, 2012). This scale is popular for measuring ordinal data (Bhattacharjee, 2012).

Table 6 shows the measures used for this study. The table indicates the construct name as per the conceptual model, the measures for each construct and the source where the measure can be found. Measures were adapted from the source to make it appropriate for this study. This instrument was used for the quantitative part of the study.

Table 6: Research instrument measures

Construct	Item Code	Measure	Source(s)
Top management support	TMS1	Top management encourages the use of Business Intelligence	(Wixom & Watson, 2001) (Yeoh, Koronios, & Gao, 2008) (Yeoh & Popovič, 2016) (Arnott, 2008)
	TMS2	Top management sponsors Business Intelligence initiatives	(Kulkarni & Robles-Flores, 2013)

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			(Yeoh, Koronios, & Gao, 2008) (Olbrich, Poppelbuß, & Niehaves, 2012) (Yeoh & Popovič, 2016) (Salehi Nasab, Selamat, & Masrom, 2015)
	TMS3	Top management is committed to hiring employees with the appropriate skills	(Kulkarni & Robles-Flores, 2013) (Yeoh & Popovič, 2016)
	TMS4	Top management is committed to retaining employees with the appropriate skills	(Kulkarni & Robles-Flores, 2013)
Data quality	DQ1	A complete data dictionary (definition list) exist for Business Intelligence fields	(Wixom & Watson, 2001) (Adamala & Cidrin, 2011) (Yeoh & Popovič, 2016) (Yeoh, Koronios, & Gao, 2008)
	DQ2	The data sources used to feed the Business Intelligence system is diverse	(Wixom & Watson, 2001) (Işik, Jones, & Sidorova, 2013) (Popovič, Hackney, Coelho, & Jaklič, 2012) (Yeoh, Koronios, & Gao, 2008)
	DQ3	Minimal transformation is required on source system data	(Wixom & Watson, 2001) (Popovič, Hackney, Coelho, & Jaklič, 2012)
Adequate resources	AR1	The Business Intelligence team is properly funded	(Wixom & Watson, 2001) (Arnott, 2008) (Iffat, M, Ahmad, & Rabail, 2015)
	AR2	The Business Intelligence team has enough team members to get work done	(Wixom & Watson, 2001) (Arnott, 2008)
	AR3	The Business Intelligence team is provided with enough time to complete their tasks	(Wixom & Watson, 2001)
Appropriate team skills	TS1	Members of the Business Intelligence team have sufficient technical skills	(Wixom & Watson, 2001) (Arnott, 2008) (Mungree, Rudra, & Morien, 2013)
	TS2	Members of the Business Intelligence team have sufficient soft skills	(Wixom & Watson, 2001) (Arnott, 2008) (Mungree, Rudra, & Morien, 2013)
	TS3	Members of the Business Intelligence team have sufficient analytical skills	(De Jager & Brown, 2016)
BI technology fit for the business	FIT1	The Business Intelligence technology works well with other existing technologies	(Wixom & Watson, 2001) (Hartley & Seymour, 2015) (Arnott, 2008)
	FIT2	The Business Intelligence technology is scalable	(Yeoh & Koronios, 2010) (Adamala & Cidrin, 2011) (Sangar & Iahad, 2013) (Yeoh & Popovič, 2016) (Salehi Nasab, Selamat, & Masrom, 2015) (Ravasan & Savoji, 2014)
	FIT3	The Business Intelligence technology is flexible	(Yeoh & Koronios, 2010) (Adamala & Cidrin, 2011) (Sangar & Iahad, 2013) (Yeoh & Popovič, 2016) (Salehi Nasab et al., 2015) (Ravasan & Savoji, 2014)
Incremental project management methodology	PMM1	The Business Intelligence team uses an incremental delivery approach	(Yeoh, Koronios, & Gao, 2008) (Bijker & Hart, 2013) (Mungree, Rudra, & Morien, 2013) (Yeoh & Popovič, 2016) (Salehi Nasab, Selamat, & Masrom, 2015) (Hartley & Seymour, 2015) (Yeoh & Koronios, 2010)
	PMM2	The Business Intelligence team does not make large scale changes when implementing solutions	(Yeoh, Koronios, & Gao, 2008) (Bijker & Hart, 2013) (Mungree, Rudra, & Morien, 2013) (Yeoh & Popovič, 2016)

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			(Salehi Nasab, Selamat, & Masrom, 2015) (Hartley & Seymour, 2015) (Yeoh & Koronios, 2010)
Align BI with business objectives	ALG1	The Business Intelligence strategy aligns to the corporate strategy	(Bijker & Hart, 2013) (Adamala & Cidrin, 2011) (Yeoh & Koronios, 2010) (Mungree, Rudra, & Morien, 2013) (Yeoh & Popovič, 2016) (Ravasan & Savoji, 2014)
	ALG2	There is a clear link between Business Intelligence projects and business objectives	(Bijker & Hart, 2013) (Adamala & Cidrin, 2011) (Yeoh & Koronios, 2010) (Mungree, Rudra, & Morien, 2013) (Yeoh & Popovič, 2016) (Ravasan & Savoji, 2014)
Well defined business requirements	REQ1	The Business Intelligence requirements are properly documented	(Mungree, Rudra, & Morien, 2013) (Olszak & Ziemba, 2012) (Arnott, 2008) (Yeoh & Popovič, 2016) (Ravasan & Savoji, 2014)
	REQ2	The Business Intelligence requirements are agreed upon before the Business Intelligence projects start	Mungree, Rudra, & Morien, 2013) (Olszak & Ziemba, 2012) (Arnott, 2008) (Yeoh & Popovič, 2016) (Ravasan & Savoji, 2014)
User participation	UP1	Business Intelligence team members and users work together on Business Intelligence projects	(Wixom & Watson, 2001) (Adamala & Cidrin, 2011) (Yeoh & Koronios, 2010) (Olszak & Ziemba, 2012) (Ravasan & Savoji, 2014) (Foshay & Kuziemy, 2014)
	UP2	Users are assigned full-time to certain Business Intelligence project tasks	(Wixom & Watson, 2001) (Adamala & Cidrin, 2011) (Yeoh & Koronios, 2010) (Olszak & Ziemba, 2012) (Ravasan & Savoji, 2014) (Foshay & Kuziemy, 2014)
	UP3	Users perform hands-on activities during Business Intelligence projects	(Wixom & Watson, 2001) (Adamala & Cidrin, 2011) (Yeoh & Koronios, 2010) (Olszak & Ziemba, 2012) (Ravasan & Savoji, 2014) (Foshay & Kuziemy, 2014)
Effective change management	CM1	Users are involved within the change management process	(Yeoh & Koronios, 2010) (Yeoh, Koronios, & Gao, 2008) (Olszak & Ziemba, 2012) (Iffat, M, Ahmad, & Rabail, 2015) (Mungree, Rudra, & Morien, 2013) (Yeoh & Popovič, 2016)
	CM2	The Business Intelligence team provides users with sufficient training and support after Business Intelligence delivery	(Mungree, Rudra, & Morien, 2013) (Adamala & Cidrin, 2011) (Bijker & Hart, 2013) (Yeoh, Koronios, & Gao, 2008) (Olszak & Ziemba, 2012) (Salehi Nasab, Selamat, & Masrom, 2015)
Net benefits	BEN1	Business Intelligence enhances the organization's decision making capabilities	(Fisher, Drucker, & Czerwinski, 2014) (Adamala & Cidrin, 2011) (Yeoh, Koronios, & Gao, 2008) (Arnott, 2008) (Mungree, Rudra, & Morien, 2013)

	BEN2	Business Intelligence increases the organization's ability to predict future scenarios	(Ranjan, 2009) (Yeoh, Koronios, & Gao, 2008) (Negash, 2004) (Bogza & Zaharie, 2008)
	BEN3	Business Intelligence reduces the organization's time it takes to make decisions	(Chaudhuri, Dayal, & Narasayya, 2011) (Işik, Jones, & Sidorova, 2013) (Rouhani et al., 2016)
	BEN4	Business Intelligence increases the organization's productivity	(Kulkarni & Robles-Flores, 2013) (Dinter, Schieder, & Gluchowski, 2001) (Ravasan & Savojo, 2014)

21.8 Target population

The target population was BI professionals in South Africa. These BI professionals vary in terms of experience and role. BI professionals include BI developers, BI analysts, BI project managers, BI managers and data scientists (De Jager & Brown, 2016). Users of BI technology were included in the definition of BI professionals for this research. Literature could not be found that states the number of BI professionals within South Africa. It was assumed this number equates to 10000.

21.9 Sample

The total size of the population was unknown. Assuming that South Africa has 10000 BI professionals, Saunders et al. (2009) recommend that 370 survey responses are required to achieve a 95% confidence level and 5% confidence interval. Peduzzi et al. (1996) argue that satisfactory results can be achieved if ten events per variable (EPV) are obtained, when doing logistic regression analysis. Vittinghoff and McCulloch (2007) determined that the rule of ten EPV can be relaxed. In their study they calculated that satisfactory results can be achieved when receiving less than ten EPV for Cox and logistic regression analysis studies. A study conducted by Austin and Steyerberg (2015) mentioned that two EPV can be used to achieve satisfactory results when conducting linear regression analysis.

The goal of quantitative sampling is to extract a sample that represents the population in order for the results of the study to be generalizable back to the population (Marshall, 1996). This research aimed to collect 100 online survey responses for the quantitative part of the study. The conceptual model contains ten independent variables. The study aimed to achieve satisfactory results by receiving ten online survey responses per construct (Peduzzi et al., 1996; Vittinghoff & McCulloch, 2007; Austin & Steyerberg, 2015). An organization with approximately 500 BI professionals was targeted to partake in the online survey. The survey was also distributed on social network platforms, such as LinkedIn, to groups that align to the population of the study. Emails were sent to BI professionals identified through LinkedIn. They were asked to partake in the study and to forward the survey to other BI professionals.

Adler and Ziglio as cited by Dawson and Van Belle (2013) state that satisfactory results can be achieved by using small sample sizes such as 10 to 15 interview participants. This research aimed to interview ten to fifteen BI professionals within South Africa for the qualitative part

of the study. Judgement sampling was used to select the interview participants. This allowed the researcher to select participants who are aligned to the population of the study (Marshall, 1996). Only five participants were interviewed due to time constraints. It can be argued that the rule of 10 to 15 required participants could be relaxed if the interviews are for validation and corroboration purposes.

21.10 Pilot study

A pilot study was conducted. The research instrument was sent via email to five BI professionals. These professionals were considered to be experienced in their field. Their years of experience ranged from 10- to 25 years. Each of the five BI professionals provided feedback on the research instrument. They all mentioned that the instrument should not be adjusted and that the questions are valid for the target population.

21.11 Data collection

An online survey tool, Qualtrics, was used to create the survey and store the responses. The survey hyperlink was sent to various LinkedIn groups that fitted the profile of the population to be studied. This link was also sent to the organization participating in the study. In addition, the link was sent to various BI professionals directly. They were requested to forward the survey to other BI professionals.

The survey ran for a specific time period, from early May 2017 to early June 2017. Once the results of the survey were analysed, semi-structured interviews were conducted with BI professionals. Judgement sampling was used in order to select participants who align to the population of the study. The sample of BI professionals included participants with different roles and experience levels.

21.12 Data analysis

Qualitative data is also known as non-numeric data (Saunders et al., 2009). This data can be gathered from interviews, questionnaires or transcripts. Thematic analysis, which forms part of qualitative analysis, is used to extract common themes from data (Vaismoradi, Turunen, & Bondas, 2013). Quantitative data analysis is used to identify patterns within numerical datasets and is usually associated with statistics, graphs and charts (Saunders et al., 2009).

This study used both quantitative and qualitative data analysis techniques. Online survey response data was exported from Qualtrics and imported into a statistical tool called SPSS. The researcher selected this tool as he is familiar with its use. UCT was able to obtain student licenses for this tool. The data was cleaned before being imported into SPSS.

The data was tested for normality using the Shapiro-Wilk and Kolmogorov-Smirnov tests (Ghasemi & Zahediasl, 2012). Internal consistency and reliability were tested using the Cronbach's Alpha method (Gliem & Gliem, 2003). This test was used to determine whether the same or similar questions will be answered with the same response each time. Factor

analysis was conducted to clean up the constructs (Abdi & Williams, 2010). Principal component analysis was used to determine the amount of factors the variables load on. Correlation analysis and regression analysis were used to test if the CSFs influence BI net benefits. Spearman's rank correlation coefficient was used to measure the relationships between the CSFs (Adler & Parmryd, 2010). Semi-structured interviews were conducted with participants after the statistical analysis was completed. The primary purpose of the semi-structured interviews was to confirm the results of the statistical analysis (Venkatesh et al., 2013; Venkatesh et al., 2016) and to explain why the CSFs are important to realize BI net benefits.

21.13 Ethical considerations

The researcher clearly stated the purpose of the research to all participants. The participant's personal and organizational details remain anonymous. Ethics approval was obtained from the UCT Ethics committee. The participants were made aware that their participation is voluntary and that they can withdraw from the online survey or interview process at any stage.

22 Quantitative analysis and findings

Data was exported from Qualtrics and saved as an Excel file. Excel was used as tool to clean up and manipulate the data before importing it into SPSS version 24 for statistical analysis.

22.1 Data cleanup and manipulation

The data contained 132 responses. Of the 132 responses, 83% (n=109) were fully completed while 17% (n=23) were partially completed.

Table 7: Number of completed responses

Completed	N
No	23
Yes	109
Total	132

The 23 partially completed responses were split into the following: 8 responses where the survey was only 3% completed and 15 responses where the survey was 16% completed.

Table 8: Completed %

Completed %	N
3	8
16	15
100	109
Total	132

The 23 partially completed responses were removed from the dataset. The number of valid responses used for the data analysis was 109.

22.1.1 Moderator cleansing: Industry

Respondents were able to select “Other” when specifying the industry in which they worked in. Respondents were then allowed to write in which industry they worked, using free-text. There were 35 respondents who selected “Other” as their industry. Table 9 provides a breakdown of these 35 responses. “Input value” is the value which the respondent populated in the free-text field. The “Mapped value” is the value that was used when importing the data into SPSS.

Table 9: Industry - Other

Input value	Mapped value	N
Analytics (Retail)	Retail	1
Asset Administration	Financial services	1
Asset Care Engineering	Financial services	1
Assurance	Financial services	1
Consulting	Consulting	1
Consulting - across industries	Consulting	1
E commerce	eCommerce	1
eCommerce	eCommerce	2
E-Commerce	eCommerce	1
Finacial service provider (Loans & Insurance)	Financial services	1
Financial	Financial services	1
Financial Services	Financial services	2
Marketing Research	Research	1
Media	Media	4
Media and Publishing	Media	1
Oil and Gas	Oil and gas	1
Oil and Has	Oil and gas	1
Online entertainment	eCommerce	1
Personal Health	Healthcare	1
Research	Research	1
Retail	Retail	5
Retail Financial Services	Financial services	1
Telecommunications	Telecommunications	4
Total		35

Table 10 shows how the 35 responses were mapped and the number of responses per mapped value.

Table 10: Industry - Mapped values

Mapped value	N
Consulting	2
eCommerce	5
Financial services	8
Healthcare	1

Mapped value	N
Media	5
Oil and gas	2
Research	2
Retail	6
Telecommunications	4
Total	35

Some of the original industry values were also re-mapped to keep the distinct list of values down to a manageable amount. Table 11 provides a list of the old values as well as the new mapped values. These are the values used while importing the data into SPSS.

Table 11: Industry - New values

Old value	Mapped value
Insurance	Financial services
Banking	Financial services
Investments	Financial services

22.1.2 Moderator cleansing: Role

There were 18 responses where “Other” was selected when asked about the role of the respondent. Table 12 provides a breakdown of the 18 responses. The values were mapped to new values. “BI architect” and “Data scientist” were identified as new roles which did not form part of the survey. These roles align to a study conducted by De Jager and Brown (2016). The values selected as “Other” were re-mapped before being imported into SPSS.

Table 12: Role - Other

Input value	Mapped value	N
Analyst Developer	BI developer	1
BI Architect	BI architect	1
BI Consultant (BIBA)	BI analyst	1
BI Specialist	BI developer	1
Business Analyst	BI analyst	1
Business analyst	BI analyst	1
DATA Lead and COA Owner	Data user	1
data scientist	Data scientist	1
Lead Business Analyst	BI analyst	1
Product Manager	Data user	1
Product Owner	Data user	1
Programmer	BI developer	1
Risk Advisory Manager	Data user	1
Senior BI Specialist	BI developer	1
Software Engineer	BI developer	1
Solutions Architect	BI architect	1
Specialist Decision Systems	BI developer	1
Training Specialist	BI developer	1

Input value	Mapped value	N
Total		18

22.1.3 Moderator cleansing: Education

There were no responses where “Other” was selected for the survey question relating to education. No data cleansing was required for this variable.

22.1.4 Reverse coding

A low value for the second measure of the data quality (DQ) construct represents a positive result. The values for this measure (DQ2) were thus reversed before importing the results into SPSS.

22.2 Demographics of respondents

22.2.1 Industry

Figure 8 provides a breakdown of the various industries of the respondents. The top industries were information technology (43%) and financial services (32%), which when combined make up 75% of the total.

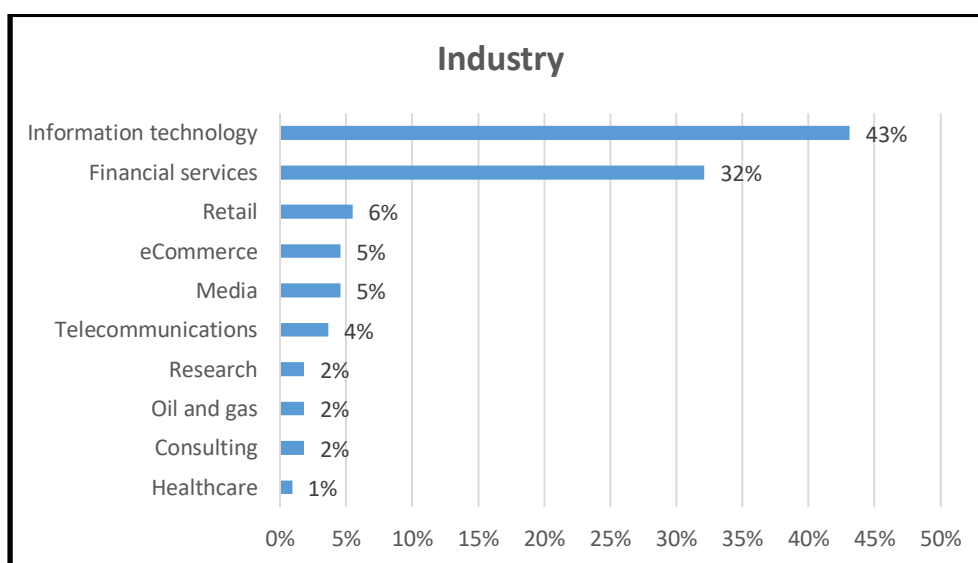


Figure 8: Industry

22.2.2 Company size

Figure 9 shows that 55% of respondents are employed by companies that have more than 1000 employees. 28% of respondents work for companies which employ between 200 and 1000 employees. Small companies (21 to 50 employees) employ 7% of respondents, medium-size companies (51 to 200 employees) employ 5% of respondents, while micro (up to 5 employees) and very small firms (6 to 20 employees) employ 3% and 2% of the respondents.

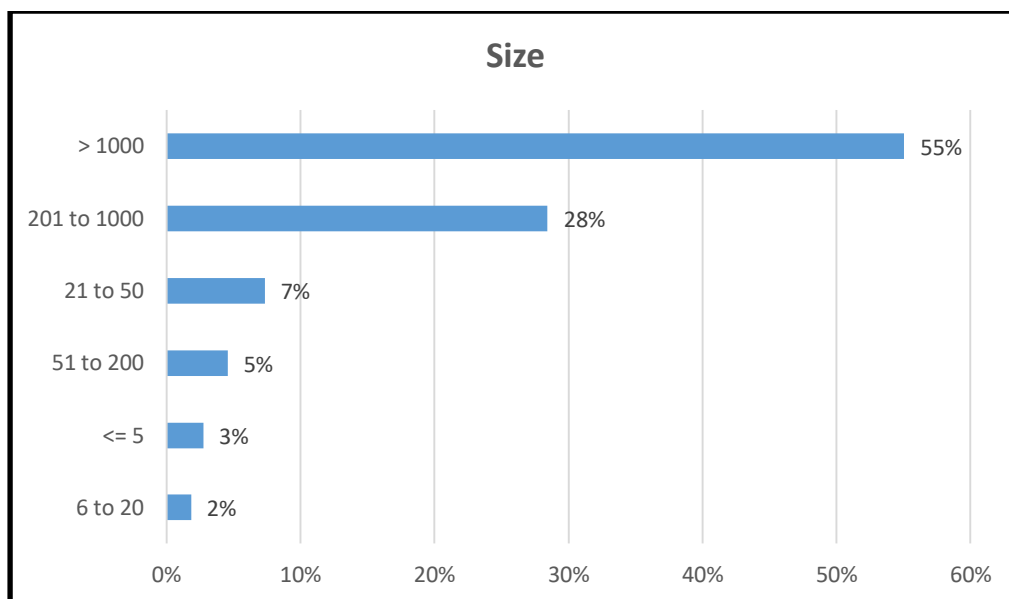


Figure 9: Size

22.2.3 Role

BI developers (36%) and BI analysts (26%) are the top occupied roles by the respondents. Data users (12%) and BI managers (11%) contributed similarly to the total sample. Roles that were not well represented in the sample dataset were BI project managers (6%), BI architects (2%) and data scientists (1%).

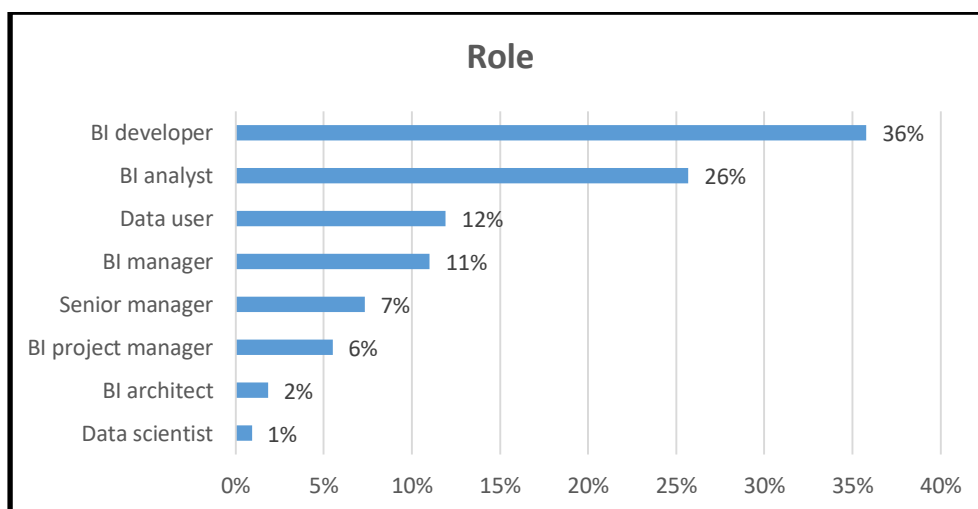


Figure 10: Role

22.2.4 Experience

The majority of respondents (39%) were junior to intermediate with 1 to 5 years of experience. Respondents with experience of 6 to 10- and 11 to 20 years both contributed 26% each to the sample dataset. Respondents new to the working environment (less than 1 year experience) made up 7% of the total responses. Those with more than 20 years of experience

contributed to only 3%. Figure 11 provides a breakdown of the experience level (in years) of the respondents.

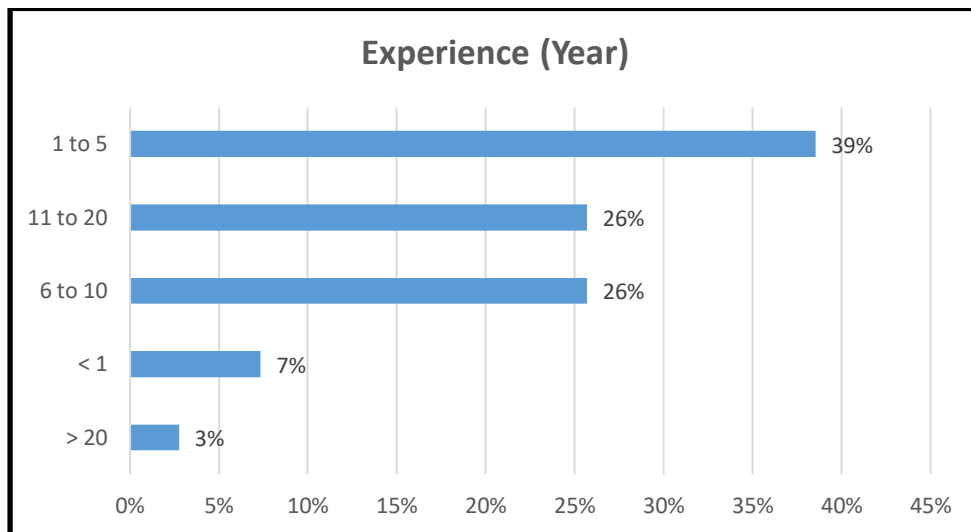


Figure 11: Experience

22.2.5 Education level

Respondents were asked to indicate their highest level of education. 89% of respondents indicated that they have higher education, i.e. not just a matric level education. This could imply that BI is a skilled profession which requires a higher level of education. A complete breakdown of the education level of respondents is presented in Figure 12.

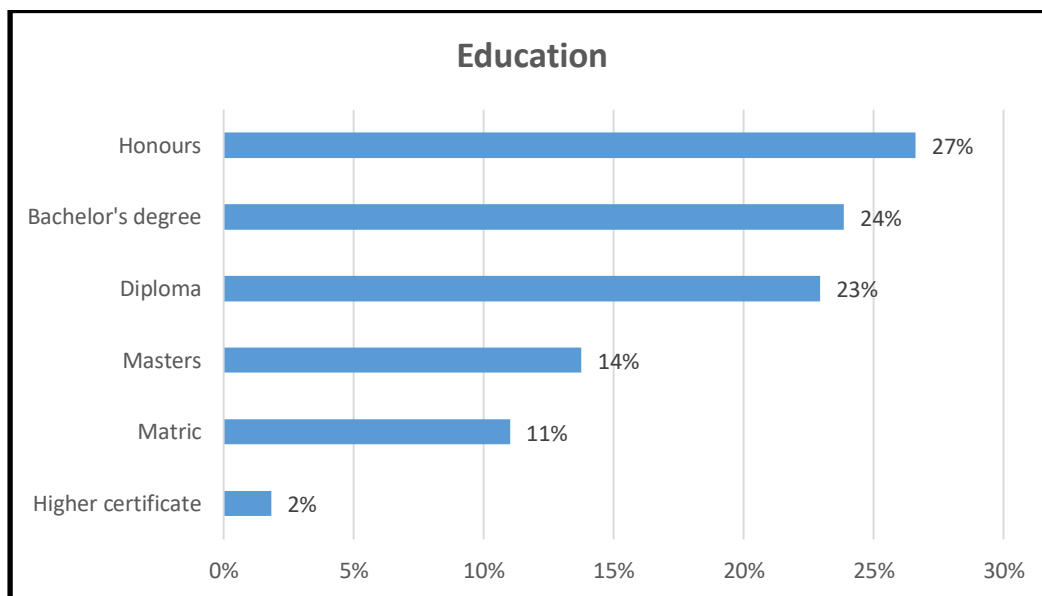


Figure 12: Education

22.3 Reliability analysis

Cronbach’s Alpha was used to test the internal reliability of the items for each construct. The purpose of Cronbach’s Alpha is to measure if similar questions (relating to the same construct) will yield similar responses. Straub, Boudreau and Gefen (2004) mention that a value of 0.6 and above is considered an acceptable Cronbach’s Alpha value for positivist research in the field of information systems. A Cronbach’s Alpha value of 0 represents no internal consistency, while a value of 1 represents perfect internal consistency (Cortina, 1993).

Table 13: Reliability Statistics

Construct	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Top management support	0.80	0.81	4
Data quality	0.45	0.40	3
Adequate resources	0.78	0.78	3
Appropriate team skills	0.75	0.75	3
BI technology fit for the business	0.81	0.81	3
Incremental project management methodology	0.28	0.28	2
Align BI with business objectives	0.80	0.81	2
Well defined business requirements	0.80	0.80	2
User participation	0.70	0.71	3
Effective change management	0.59	0.59	2
Net benefits	0.84	0.84	4

Table 13 shows the results of the Cronbach’s Alpha test that was conducted on the sample dataset. The majority of the constructs indicate good internal consistency with Cronbach’s Alpha values above the acceptable minimum value of 0.6. Data quality, incremental project management methodology and effective change management show weak internal consistency with Cronbach’s Alpha values of 0.45, 0.28 and 0.59 respectively.

Table 14: Item-Total Statistics

Item Code	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TMS1	11.33	4.80	0.64	0.45	0.75
TMS2	11.67	4.59	0.58	0.42	0.76
TMS3	11.72	3.85	0.71	0.51	0.69
TMS4	12.06	3.93	0.55	0.36	0.79
DQ1	4.04	2.00	0.34	0.26	0.24
DQ2	5.13	3.45	0.04	0.06	0.65
DQ3	4.47	1.42	0.51	0.27	-.196a
AR1	5.81	3.56	0.61	0.40	0.71
AR2	6.09	3.34	0.68	0.47	0.63
AR3	5.99	3.64	0.56	0.32	0.77
TS1	7.05	2.47	0.63	0.40	0.61
TS2	7.47	2.40	0.51	0.27	0.74

Item Code	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TS3	7.17	2.37	0.59	0.37	0.65
FIT1	7.61	2.76	0.56	0.32	0.83
FIT2	7.46	2.29	0.74	0.56	0.66
FIT3	7.56	1.97	0.71	0.54	0.70
PMM1	3.49	0.73	0.16	0.03	
PMM2	3.76	0.70	0.16	0.03	
ALG1	3.69	0.90	0.68	0.46	
ALG2	3.86	0.66	0.68	0.46	
REQ1	3.19	0.95	0.67	0.44	
REQ2	2.91	1.05	0.67	0.44	
UP1	6.45	3.40	0.45	0.22	0.70
UP2	7.06	2.40	0.52	0.30	0.62
UP3	6.70	2.56	0.61	0.38	0.49
CM1	3.42	0.95	0.42	0.18	
CM2	3.27	0.94	0.42	0.18	
BEN1	12.22	4.58	0.59	0.39	0.83
BEN2	12.60	3.58	0.73	0.55	0.77
BEN3	12.49	3.81	0.71	0.52	0.78
BEN4	12.43	4.15	0.67	0.49	0.80

Table 14 provides a list of items as well as the Cronbach's Alpha value of the construct if the item was to be deleted. If DQ2 is to be removed from the data quality construct, the Cronbach's Alpha value for the construct will be 0.65. This value is above the acceptable minimum Cronbach's Alpha value of 0.6. Removal of any other items will result in a lower Cronbach's Alpha value, except for FIT1. If this item is removed the Cronbach's Alpha value for the BI technology fit for the business construct will increase slightly.

22.4 Construct validity

Factor analysis was conducted to validate the constructs. This technique is used to measure the interrelationships between items and to identify the underlying factors of these items. By determining the factors which the items load on, factor analysis provides a technique to clean up the constructs (Straub, Boudreau, & Gefen, 2004). The minimum acceptable factor loading value for construct items is 0.5 (Osborne & Costello, 2009). The closer the factor loadings are to the value 1, the greater that item contributes to the factor (Abdi & Williams, 2010).

The number of factors which the items load on can be determined by counting all factors where the Eigenvalue is greater than 1 (Straub et al., 2004). The Scree plot can also be used to determine the number of factors. The number of factors is determined by the sharp drop in values also known as the elbow (Norris & Lecavalier, 2010).

Table 15: Total Variance Explained

Factor	Eigenvalue	% of Variance	Cumulative %
1	9.05	29.18	29.18
2	3.06	9.89	39.07
3	2.10	6.78	45.85
4	1.73	5.57	51.42
5	1.35	4.37	55.79
6	1.27	4.10	59.89
7	1.09	3.53	63.42
8	1.06	3.43	66.85
9	1.03	3.32	70.17
10	0.97	3.12	73.29

Table 15 shows that the items load on 9 factors, i.e. the number of factors where the Eigenvalue is greater than 1. The 9 factors account for 70.17% of the total variance of the data. Principal component analysis was used as the extraction method. The Scree plot (Figure 13) shows that the Eigenvalues are above 1 for factors 1 to 9.

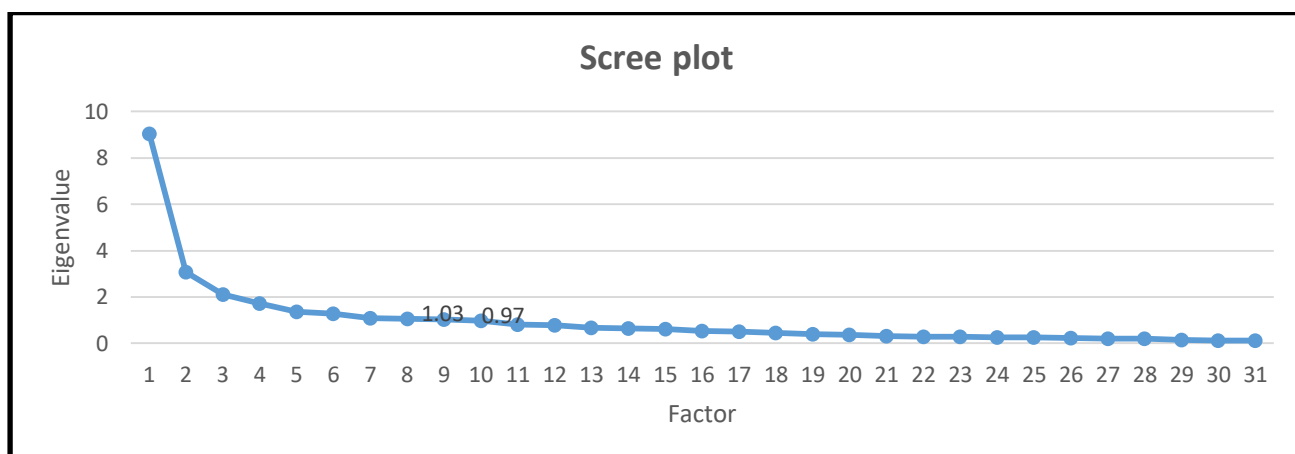


Figure 13: Scree plot

Factor analysis was conducted using the Varimax normalized rotation. Extraction was based on Eigenvalues greater than 1. Table 16 shows the loading factor values greater than 0.3. Values are highlighted in red if they are above the acceptable minimum of 0.5. TMS1 to TMS4 loaded well together on factor 1. AR1 which relates to the funding of the BI team also loaded well on factor 1. Yeoh and Koronios (2010) mention that funding is provided by top management support which could explain why this item loaded well with the TMS items. AR1 was grouped with the TMS items to form the TMSV latent variable.

The BI net benefits items (BEN1 to BEN4) loaded well together on factor 2. REQ1 and REQ2 loaded well together on factor 3, together with PMM2 and DQ3. PMM2 refers to large scale changes made during BI projects. If small incremental changes are made by following

an agile methodology, these changes will be documented, before being implemented. This could explain why PMM2 loaded well with the REQ items which represent well defined requirements. DQ3 which refers to transformation of source system data also loaded on factor 3. This item could not be explained and was removed. A latent variable (REQV) was created which groups REQ1, REQ2 and PMM2.

The items relating to BI technology being a good fit for business use (FIT items) loaded well together on factor 4. UP2 and UP3 loaded sufficiently on factor 5. AR2 which relates to sufficient number of team members also loaded well on factor 5. It could be argued that sufficient team members for BI projects include external users outside of the BI team. This could explain why AR2 loaded well with the user participation items. These items were grouped together to form the UPV latent variable.

The TS items loaded well together on factor 6. Items that measure alignment between BI and business objectives (ALG1 and ALG2) load well together on factor 7. UP1 and CM2 load well on factor 8. These items both relate to collaboration between BI and external users and were grouped together into the latent variable COLLAB. DQ2 could not be explained for loading well on factor 8 and was removed. PMM1 loaded well on factor 9. DQ1, AR3 and CM1 did not load above the minimum acceptable value of 0.5 on any factor and were removed.

Table 16: Factor analysis with Varimax normalized rotation

Item	Factor								
	1	2	3	4	5	6	7	8	9
TMS3	0.78								
TMS1	0.77								
TMS2	0.69								
TMS4	0.67						0.30		
AR1	0.53				0.45				
BEN2		0.82							
BEN3		0.80							
BEN4		0.76							
BEN1		0.58						0.54	
REQ2			0.74						
REQ1			0.66						
PMM2			0.64						
DQ3			0.63						
DQ1			0.48		0.35				
FIT3				0.81					
FIT2				0.77					
FIT1				0.70					
UP3					0.79				
UP2					0.78				
AR2	0.41				0.51		0.36		
TS3						0.74			
TS1	0.39					0.71			
TS2			0.30			0.66			
AR3		-0.31			0.39	0.39	0.39		
ALG2		0.34					0.77		
ALG1		0.34					0.68		
DQ2								-0.69	-0.31
UP1			0.36		0.37			0.59	
CM2				0.49				0.51	
CM1				0.33				0.44	
PMM1									0.81

Factor analysis indicated that the items load on 9 factors and not 11 as expected (10 independent variables and 1 dependent variable). Data quality as a construct was removed completely from the conceptual model. Adequate resources was also removed as a construct, with the items loading with either top management support- or user participation constructs. Change management was replaced with a construct that was named as “Collaboration”. The final items and their associated construct names are shown in Table 17.

Table 17: Final items after factor analysis

Construct	Construct code	Item code	New item code
Top management support	TMSV	AR1	TMSV1
		TMS1	TMSV2
		TMS2	TMSV3
		TMS3	TMSV4

Construct	Construct code	Item code	New item code
		TMS4	TMSV5
Appropriate team skills	TS	TS1	TS1
		TS2	TS2
		TS3	TS3
BI technology fit for the business	FIT	FIT1	FIT1
		FIT2	FIT2
		FIT3	FIT3
Incremental project management	PMM	PMM1	PMM
Align BI with business objectives	ALG	ALG1	ALG1
		ALG2	ALG2
Well defined business requirements	REQV	PMM2	REQV1
		REQ1	REQV2
		REQ2	REQV3
User participation	UPV	AR2	UPV1
		UP2	UPV2
		UP3	UPV3
Collaboration	COLLAB	CM2	COLLAB1
		UP1	COLLAB2
Net benefits	BEN	BEN1	BEN1
		BEN2	BEN2
		BEN3	BEN3
		BEN4	BEN4

22.5 Reliability analysis (Revised)

Reliability analysis was conducted on the revised dataset (see Table 17), i.e. post the factor analysis exercise. All items showed good internal consistency with Cronbach’s Alpha values higher than the minimum acceptable value of 0.6. The “Collaboration” construct showed poor internal consistency with a Cronbach’s Alpha value of 0.53. This is shown in Table 18.

Table 18: Reliability statistics (Revised)

Construct	Cronbach's Alpha	N of Items
Top management support	0.81	5
Appropriate team skills	0.75	3
BI technology fit for the business	0.81	3
Incremental project management methodology	N/a (Only 1 item)	1
Align BI with business objectives	0.80	2
Well defined business requirements	0.71	3
User participation	0.70	3
Collaboration	0.53	2
Net benefits	0.84	4

Table 19: Item-Total Statistics (Revised)

Item Code	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
COLLAB1	3.65	0.69	0.37	
COLLAB2	3.42	0.95	0.37	

The corrected item-total correlation for the “Collaboration” construct is less than 0.5. This provides further indication of poor internal consistency for the “Collaboration” construct (Wu, 2007). Collaboration was removed as a construct due to poor internal consistency of the items.

Table 20 provides a list of the final constructs and items that was used for hypotheses testing.

Table 20: Final items after revised reliability analysis

Construct	Construct code	Item code
Top management support	TMSV	TMSV1
		TMSV2
		TMSV3
		TMSV4
		TMSV5
Appropriate team skills	TS	TS1
		TS2
		TS3
BI technology fit for the business	FIT	FIT1
		FIT2
		FIT3
Incremental project management	PMM	PMM
Align BI with business objectives	ALG	ALG1
		ALG2
Well defined business requirements	REQV	REQV1
		REQV2
		REQV3
User participation	UPV	UPV1
		UPV2
		UPV3
Net benefits	BEN	BEN1
		BEN2
		BEN3
		BEN4

22.6 Construct validity (Revised)

Factor analysis was executed using the items as per Table 20. The number of factors was set to 8 which is in line with the number of constructs as per Table 20. Varimax normalized

rotation was used as rotation method. Principal component method was used as extraction method. Table 21 shows the output with factor loadings equal to 0.5 and above highlighted in red. The minimum acceptable factor loading is 0.5 (Osborne & Costello, 2009).

Table 21: Factor analysis with Varimax normalized rotation

Item	Factor							
	1	2	3	4	5	6	7	8
TMSV4	0.75							
TMSV2	0.75							
TMSV3	0.73							
TMSV5	0.72							
TMSV1	0.57			0.40				
UPV1	0.48			0.44				
BEN2		0.85						
BEN3		0.76						
BEN1		0.75						
BEN4		0.71						
FIT3			0.83					
FIT2			0.82					
FIT1			0.67					
UPV3				0.83				
UPV2				0.83				
TS3					0.83			
TS1					0.73			
TS2					0.50		0.49	
ALG2						0.84		
ALG1						0.72		
REQV1							0.90	
REQV2							0.41	
PMM								0.78
REQV3								0.49

Table 21 shows that UPV1, REQV2 and REQV3 loaded below the minimum acceptable factor loading value of 0.5. These items were removed. Factor analysis was re-executed using the same extraction- and rotation method as per above. The number of factors was once again set to 8.

Table 22 shows that all factors loaded as expected, except for TS2. This item loaded weak on factor 4 with the other TS items. A reliability test for the TS constructs showed good internal consistency of the items. Table 23 shows the Cronbach's Alpha was above the recommended minimum of 0.6 (Straub, Boudreau, & Gefen, 2004). Table 24 reveals that none of the items could be removed to increase the Cronbach's Alpha above 0.75 (Table 23). It was concluded that TS items will remain grouped together due to the high internal consistency value of 0.75 for these items.

Table 22: Factor analysis with Varimax normalized rotation

Item	Factor							
	1	2	3	4	5	6	7	8
TMSV4	0.78							
TMSV2	0.76							
TMSV3	0.74							
TMSV5	0.72							
TMSV1	0.55							
BEN2		0.87						
BEN3		0.76						
BEN1		0.76						
BEN4		0.72						
FIT3			0.82					
FIT2			0.80					
FIT1			0.75					
TS3				0.84				
TS1				0.74				
UPV3					0.84			
UPV2					0.84			
ALG2						0.86		
ALG1						0.79		
REQV1							0.92	
TS2				0.47			0.52	
PMM								0.84

Table 23: Reliability Statistics

Construct	Cronbach's Alpha	N of Items
Appropriate team skills	0.75	3

Table 24: Item-Total Statistics

Item code	Cronbach's Alpha if Item Deleted
TS1	0.61
TS2	0.74
TS3	0.65

22.7 Final items used for hypotheses testing

Table 25 shows the final items used for hypotheses testing. The mean of the items for each construct was used as the construct value for hypotheses testing.

Table 25: Final items to be used for hypotheses testing

Construct	Construct code	Item code
Top management support	TMSV	TMSV1
		TMSV2
		TMSV3
		TMSV4
		TMSV5
Appropriate team skills	TS	TS1
		TS2

Construct	Construct code	Item code
		TS3
BI technology fit for the business requirements	FIT	FIT1
		FIT2
		FIT3
Incremental project management methodology	PMM	PMM
Align BI with business objectives	ALG	ALG1
		ALG2
Well defined business requirements	REQV	REQV1
User participation	UPV	UPV2
		UPV3
Net benefits	BEN	BEN1
		BEN2
		BEN3
		BEN4

22.8 Normality analysis

Two tests were used to determine the constructs for normality, i.e. the Kolmogorov-Smirnov and Shapiro-Wilk tests. Table 26 shows the results of the normality tests conducted. The results show that only construct TMSV (Top management support) is normally distributed. All other constructs are statistically significant ($p < 0.05$). H_0 hypothesis is thus rejected and all constructs (excluding top management support) are considered to be non-normally distributed (Saunders et al., 2009). Top management support (TMSV) is normally distributed with $p > 0.05$ ($p = 0.06$) for both the Kolmogorov-Smirnov and Shapiro-Wilk tests.

Table 26 : Normality analysis

Construct	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Top management support (TMSV)	0.08	109	0.06	0.98	109	0.06
Appropriate team skills (TS)	0.15	109	0.00	0.95	109	0.00
BI technology fit for the business (FIT)	0.20	109	0.00	0.90	109	0.00
Incremental project management methodology (PMM)	0.33	109	0.00	0.83	109	0.00
Align BI with business objectives (ALG)	0.22	109	0.00	0.92	109	0.00
Well defined business requirements (REQV)	0.30	109	0.00	0.83	109	0.00
User participation (UPV)	0.16	109	0.00	0.95	109	0.00
Net benefits (BEN)	0.17	109	0.00	0.92	109	0.00

22.9 Hypotheses testing

22.9.1 Correlation analysis

The Spearman's rank correlation test was conducted to test the correlation between the constructs. This test is suitable for Likert scale ordinal constructs (Saunders et al., 2009). Values for the Spearman's rank correlation test can range from +1 to -1, where +1 represents perfect positive correlation and -1 represents perfect negative correlation. This test determines the strength of the relationships between the constructs. A value of 0 represents no correlation between the measured constructs (Saunders et al., 2009). Constructs where $p <$

0.01 are considered to have a statistically significant relationship (Miller, Freedson, & Kline, 1994).

Table 27: Spearman's rank correlation coefficient

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.492**	1.00						
BI technology fit for the business (FIT)	.298**	.481**	1.00					
Incremental project management methodology (PMM)	.245*	.289**	.430**	1.00				
Align BI with business objectives (ALG)	.381**	.345**	.308**	.288**	1.00			
Well defined business requirements (REQV)	.208*	.297**	0.15	0.18	0.15	1.00		
User participation (UPV)	.351**	.323**	.233*	.215*	.271**	0.14	1.00	
Net benefits (BEN)	.346**	.301**	.377**	.349**	.497**	0.09	0.14	1.00

** p < 0.01

* p < 0.05

Table 27 shows that:

- Top management support (TMSV) has a statistically significant relationship with all other constructs.
- Appropriate team skills (TS) has a statistically significant relationship with all other constructs.
- BI technology fit for the business (FIT) has a statistically significant relationship with all other constructs except for the well-defined business requirements (REQV) construct.
- Incremental project management methodology (PMM) has a statistically significant relationship with all other constructs except for the well-defined business requirements (REQV) construct.
- Align BI with business objectives (ALG) has a statistically significant relationship with all other constructs except for the well-defined business requirements (REQV) construct.
- Well defined business requirements (REQV) has a statistically significant relationship with Top management support (TMSV) and Appropriate team skills (TS).
- User participation (UPV) has a statistically significant relationship with Top management support (TMSV), Appropriate team skills (TS), BI technology fit for the business (FIT), Incremental project management methodology (PMM) and Align BI with the business objectives (ALG).
- Net benefits (BEN) has a statistically significant relationship with Top management support (TMSV), Appropriate team skills (TS), BI technology fit for the business (FIT), Incremental project management methodology (PMM) and Align BI with the business objectives (ALG).

22.9.2 Moderator analysis

Man Whitney-U test

The Man Whitney-U test is a non-parametric test suitable for Likert-scale constructs (Saunders et al., 2009). This test does not make assumptions about the distribution of the constructs and was used as part of the moderator analysis.

The industry variable was split into IT and non-IT respondents. Size of company was split into those with more than 1000 employees and those with less or equal to 1000 employees. The roles of the respondents were grouped into BI developers and non-BI developers. Respondents were classified as experienced if they had more than 5 years’ work experience. Respondents who had 5 years of experience or less were classified as inexperienced. Respondents were classified as “Postgraduate” for the education variable if they had an Honours or Master’s degree. All other respondents were classified as “Undergraduate”.

Table 28: Moderator analysis

Moderator	Group 1	Group 2	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Industry	IT (N = 47)	Non-IT (N = 62)	0.93	0.29	0.28	0.95	0.34	0.05	0.91	0.31
Size	<= 1000 (N = 49)	> 1000 (N = 60)	0.25	0.93	0.19	0.37	0.22	0.41	0.02	0.28
Role	BI developer (N = 39)	Non-BI developer (N = 70)	0.98	0.88	0.99	0.71	0.08	0.54	0.33	0.11
Experience	Experienced (N = 59)	Inexperienced (N = 50)	0.30	0.90	0.49	0.12	0.46	0.03	0.83	0.70
Education	Postgraduate (N = 44)	Undergraduate (N = 65)	0.66	0.02	0.25	0.89	0.63	0.44	0.51	0.44

Table 28 show the results of the Man-Whitney U test. P-values that are smaller than 0.05 are highlighted in red. Size has a statistically significant influence ($p < 0.05$) on User participation (UPV). Experience has a statistically significant influence ($p < 0.05$) on well-defined business requirements (REQV). Education has a statistically significant influence ($p < 0.05$) on appropriate team skills (TS).

Correlation analysis

The Spearman's rank correlation test was conducted for each moderator. This was done to test the impact of the moderators on the relationship between the independents variables and the dependent variables.

Table 29 : Industry = IT

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.538**	1.00						
BI technology fit for the business (FIT)	.329*	.620**	1.00					
Incremental project management methodology (PMM)	0.25	0.28	.502**	1.00				
Align BI with business objectives (ALG)	.326*	.325*	0.28	.405**	1.00			
Well defined business requirements (REQV)	0.09	0.23	0.06	0.10	0.27	1.00		
User participation (UPV)	.343*	.354*	0.28	.295*	0.25	0.04	1.00	
Net benefits (BEN)	0.11	0.20	0.27	.415**	.576**	0.17	0.14	1.00

Table 30: Industry = Non-IT

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.436**	1.00						
BI technology fit for the business (FIT)	.290*	.355**	1.00					
Incremental project management methodology (PMM)	0.24	.288*	.393**	1.00				
Align BI with business objectives (ALG)	.441**	.336**	.329**	0.19	1.00			
Well defined business requirements (REQV)	.312*	.325**	0.19	0.22	0.02	1.00		
User participation (UPV)	.338**	.294*	0.20	0.16	.269*	0.22	1.00	
Net benefits (BEN)	.499**	.373**	.443**	.310*	.434**	0.03	0.13	1.00

Table 29 and Table 30 show the results for the Industry moderator. The IT industry results show that TMSV, TS and FIT do not have a statistically significant relationship with BI net benefits. These variables do however have a statistically significant relationship ($p < 0.01$) with BI net benefits for the non-IT industry. Industry thus moderates the relationship between the independent variables TMSV, TS, FIT and the dependent variable of BI net benefits.

Table 31: Size \leq 1000

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.526**	1.00						
BI technology fit for the business (FIT)	.301*	.449**	1.00					
Incremental project management methodology (PMM)	.341*	0.27	.403**	1.00				
Align BI with business objectives (ALG)	0.25	0.17	0.18	.316*	1.00			
Well defined business requirements (REQV)	.340*	.326*	0.19	0.14	.353*	1.00		
User participation (UPV)	.317*	0.27	0.26	0.22	0.19	0.16	1.00	
Net benefits (BEN)	0.22	0.10	.308*	.342*	.613**	0.22	0.03	1.00

Table 32: Size > 1000

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.474**	1.00						
BI technology fit for the business (FIT)	.277*	.507**	1.00					
Incremental project management methodology (PMM)	0.15	.294*	.427**	1.00				
Align BI with business objectives (ALG)	.500**	.519**	.412**	.257*	1.00			
Well defined business requirements (REQV)	0.13	.262*	0.13	0.21	- 0.01	1.00		
User participation (UPV)	.365**	.380**	0.18	0.19	.321*	0.18	1.00	
Net benefits (BEN)	.412**	.457**	.422**	.359**	.374**	0.01	0.21	1.00

Table 31 and Table 32 show the results for the Size moderator. Organizations with less than 1000 employees show that TMSV and TS do not have a statistically significant relationship with BI net benefits. These variables do however have a statistically significant relationship ($p < 0.01$) with BI net benefits where the size of the organization is larger than 1000 employees. Size thus moderates the relationship between the independent variables TMSV and TS and the dependent variable of BI net benefits.

Table 33: Role = BI developer

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.502**	1.00						
BI technology fit for the business (FIT)	.365*	.418**	1.00					
Incremental project management methodology (PMM)	0.28	0.31	.366*	1.00				
Align BI with business objectives (ALG)	0.28	0.28	.389*	.334*	1.00			
Well defined business requirements (REQV)	0.13	0.05	0.17	0.16	0.31	1.00		
User participation (UPV)	0.24	.358*	.316*	0.21	0.22	0.13	1.00	
Net benefits (BEN)	.417**	0.29	.484**	.439**	.540**	.334*	0.09	1.00

Table 34: Role = Non-BI developer

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.479**	1.00						
BI technology fit for the business (FIT)	.268*	.512**	1.00					
Incremental project management methodology (PMM)	0.23	.278*	.462**	1.00				
Align BI with business objectives (ALG)	.462**	.402**	.297*	.266*	1.00			
Well defined business requirements (REQV)	.254*	.408**	0.16	0.20	0.09	1.00		
User participation (UPV)	.425**	.310**	0.20	0.21	.298*	0.15	1.00	
Net benefits (BEN)	.305*	.306**	.340**	.304*	.467**	- 0.02	0.17	1.00

Table 33 and Table 34 show the results for the Role moderator. TS do not have a statistically significant relationship with BEN for BI developers. TS do however have a statistically significant relationship ($p < 0.01$) with BEN for non-BI developers. REQV shows a statistically significant relationship ($p < 0.01$) with BEN for BI developers however for non-BI developers the relationship is not statistically significant. Role thus moderates the relationship between the independent variables TS and REQV with the dependent variables BEN.

Table 35: Experience = Experienced

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.574**	1.00						
BI technology fit for the business (FIT)	.343**	.429**	1.00					
Incremental project management methodology (PMM)	.325*	.329*	.443**	1.00				
Align BI with business objectives (ALG)	.375**	0.21	0.16	.406**	1.00			
Well defined business requirements (REQV)	.316*	.403**	0.15	0.23	0.14	1.00		
User participation (UPV)	.347**	.381**	0.19	0.23	.325*	0.15	1.00	
Net benefits (BEN)	.299*	0.22	.316*	.374**	.545**	0.06	0.04	1.00

Table 36: Experience = Inexperienced

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.396**	1.00						
BI technology fit for the business (FIT)	.281*	.552**	1.00					
Incremental project management methodology (PMM)	0.20	0.24	.376**	1.00				
Align BI with business objectives (ALG)	.373**	.496**	.476**	0.19	1.00			
Well defined business requirements (REQV)	0.05	0.16	0.21	0.19	0.12	1.00		
User participation (UPV)	.366**	0.26	.281*	0.18	0.20	0.13	1.00	
Net benefits (BEN)	.413**	.406**	.443**	.310*	.460**	0.14	0.24	1.00

Table 35 and Table 36 show the correlation results for the Experience moderator. TS show a statistically significant relationship with BEN for resources that are inexperienced. For experienced resources there is no statistically significant relationship between TS and BEN. Experience thus moderates the relationship between TS and BEN.

Table 37: Education = Postgraduate

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.375*	1.00						
BI technology fit for the business (FIT)	0.21	.424**	1.00					
Incremental project management methodology (PMM)	0.24	0.11	.336*	1.00				
Align BI with business objectives (ALG)	0.28	0.22	0.19	0.25	1.00			
Well defined business requirements (REQV)	0.10	0.17	0.06	0.12	0.14	1.00		
User participation (UPV)	0.12	0.10	0.10	0.01	0.05	0.05	1.00	
Net benefits (BEN)	.367*	.337*	0.25	.336*	.472**	-0.07	-0.04	1.00

Table 38 : Education = Undergraduate

	TMSV	TS	FIT	PMM	ALG	REQV	UPV	BEN
Top management support (TMSV)	1.00							
Appropriate team skills (TS)	.571**	1.00						
BI technology fit for the business (FIT)	.348**	.501**	1.00					
Incremental project management methodology (PMM)	.250*	.423**	.489**	1.00				
Align BI with business objectives (ALG)	.453**	.469**	.400**	.311*	1.00			
Well defined business requirements (REQV)	.280*	.375**	0.22	0.23	.369**	1.00		
User participation (UPV)	.490**	.491**	.328**	.350**	.438**	0.21	1.00	
Net benefits (BEN)	.341**	.294*	.454**	.367**	.511**	0.20	.262*	1.00

Table 37 shows that FIT and UPV do not have a statistically significant relationship with BEN for postgraduate resources. FIT and UPV are determined to have a statistically significant relationship with BEN for undergraduate resources (see Table 38). Education thus moderates the relationship between the independent variables FIT and UPV with the dependent variable BEN.

22.9.3 Single regression analysis

Each of the independent variables were tested against the dependent variable, i.e. Net benefits (BEN). A p-value of less than 0.05 indicates that the relationship between the independent and dependent variable is statistically significant (Saunders et al., 2009). The variance in the data can be explained by examining the R^2 value.

Table 39 : Single regression analysis

Construct	R	R Square	Adjusted R Square	Std. Error of the Estimate	p-value	Rank
Top management support (TMSV)	0.33	0.11	0.10	0.62	0.00045	3
Appropriate team skills (TS)	0.28	0.08	0.07	0.63	0.00324	5
BI technology fit for the business (FIT)	0.42	0.17	0.16	0.60	0.00001	2
Incremental project management methodology (PMM)	0.30	0.09	0.08	0.62	0.00147	4
Align BI with business objectives (ALG)	0.48	0.23	0.23	0.57	0.00000	1
Well defined business requirements (REQV)	0.11	0.01	0.00	0.65	0.27653	7
User participation (UPV)	0.15	0.02	0.01	0.65	0.11112	6

Table 39 shows that 5 of the 7 independent variables have a high correlation with the dependent variable (BEN). The p-value for these are less than 0.05. The variables are TMSV, TS, FIT, PMM and ALG. ALG explains 23% ($R^2 = 0.23$) of the variance in the data, FIT explains 17%, TMSV explains 11%, PMM explains 9% and TS explains 8%. REQV and UPV does not show a statistically significant relationship with BEN ($p > 0.05$).

22.9.4 Multiple regression analysis

Multiple regression analysis was conducted to test the combined effect of the independent variables on the dependent variable (BEN). A coefficient of determination (R^2) is used to predict how good the independent variables predict the dependent variable. The closer the value is to 1, the better the prediction magnitude (Saunders et al., 2009).

Table 40 : Model summary

Model summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
0.58	0.33	0.29	0.55

The model summary (Table 40) shows that the independent variables explain 33% ($R^2 = 0.33$) of the total variance in the data. Table 41 shows that FIT and ALG has a statistically significant relationship with BEN ($p < 0.05$).

Table 41: Multiple regression analysis

Construct	p-value
Top management support (TMSV)	0.241
Appropriate team skills (TS)	0.774
BI technology fit for the business (FIT)	0.005
Incremental project management methodology (PMM)	0.399
Align BI with business objectives (ALG)	0.000
Well defined business requirements (REQV)	0.923
User participation (UPV)	0.662

Multiple regression was re-executed using the “Stepwise” method. This method confirmed that BEN is predicted only by ALG and FIT when taking all the other variables into account (unlike single regression analysis). These variables explain 32% of the variance in the data. This is shown in Table 42.

Table 42: Stepwise method

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.483a	0.23	0.23	0.57
2	.565b	0.32	0.31	0.54

a. Predictors: (Constant), ALG

b. Predictors: (Constant), ALG, FIT

22.10 Hypotheses results

22.10.1 Hypothesis 1

Correlation- and single regression analysis showed that top management support has a statistically significant relationship with BI net benefits. Multiple regression analysis did not support this relationship. Industry and size moderated the relationship. The hypothesis is thus partially supported.

22.10.2 Hypothesis 2

Correlation-, single regression- and multiple regression analysis showed that well-defined business requirements did not have a statistically significant relationship with BI net benefits. Role was the only moderator which affected the relationship. The hypothesis is thus rejected.

22.10.3 Hypothesis 3

Correlation-, single regression- and multiple regression analysis showed that alignment between BI and the business objectives has a significant relationship with BI net benefits. Industry, size, role and experience did not show to be moderating factors. The hypothesis is thus partially supported.

22.10.4 Hypothesis 4

The results for this hypothesis were inconclusive as adequate resources was removed as a construct from the original model. The association between adequate resources and BI net benefits could thus not be tested.

22.10.5 Hypothesis 5

Correlation- and single regression analysis showed that appropriate team skills has a significant relationship with BI net benefits. Multiple regression analysis did not support this relationship. Industry, size, role and experience all moderate the relationship. The hypothesis is thus partially supported.

22.10.6 Hypothesis 6

Correlation- and single regression analysis showed that an incremental project management methodology has a significant relationship with BI net benefits. Multiple regression analysis did not support this relationship. Industry, size, role and experience did not show to be moderating factors. The hypothesis is thus partially supported.

22.10.7 Hypothesis 7

The results for this hypothesis were inconclusive as effective change management was removed as a construct from the original model. The association between effective change management and BI net benefits could thus not be tested.

22.10.8 Hypothesis 8

Correlation-, single regression- and multiple regression analysis showed that user participation did not have a significant relationship with BI net benefits. Education (which was not part of the conceptual model) was the only moderator which affected the relationship. This hypothesis is thus not supported.

22.10.9 Hypothesis 9

The results for this hypothesis were inconclusive as data quality was removed as a construct from the original model. The association between data quality and BI net benefits could thus not be tested.

22.10.10 Hypothesis 10

Correlation-, single regression- and multiple regression analysis showed that BI technology fit for the business has a significant relationship with BI net benefits. Industry and education were determined to be moderating factors for the relationship. The hypothesis is thus partially supported.

22.10.11 Hypothesis 11

Correlation analysis showed that top management support has a significant relationship with alignment between BI and business objectives. Thus the hypothesis was satisfied.

22.10.12 Hypothesis 12

The results for this hypothesis were inconclusive as adequate resources was removed as a construct from the original model. The association between top management support and adequate resources could thus not be tested.

22.10.13 Hypothesis 13

The results for this hypothesis were inconclusive as effective change management was removed as a construct from the original model. The association between top management support and effective change management could thus not be tested.

22.10.14 Hypothesis 14

Correlation analysis showed that top management support has a significant relationship with user participation. Thus the hypothesis was satisfied.

22.10.15 Hypothesis 15

The results for this hypothesis were inconclusive as adequate resources was removed as a construct from the original model. The association between adequate resources and appropriate team skills could thus not be tested.

22.10.16 Hypothesis 16

The results for this hypothesis were inconclusive as effective change management was removed as a construct from the original model. The association between effective change management and user participation could thus not be tested.

22.10.17 Hypotheses summary

Table 43 shows a summary of all the tested hypotheses.

Table 43: Hypotheses summary

Hypothesis	Relationship	Correlation	Single regression	Multiple regression	Industry	Size	Role	Experience	Result
H1	TMSV -> BEN	Accepted	Accepted	Rejected	Accepted	Accepted	Rejected	Rejected	Partial
H2	REQV -> BEN	Rejected	Rejected	Rejected	Rejected	Rejected	Accepted	Rejected	Rejected
H3	ALG -> BEN	Accepted	Accepted	Accepted	Rejected	Rejected	Rejected	Rejected	Partial
H4	AR -> BEN	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive
H5	TS -> BEN	Accepted	Accepted	Rejected	Accepted	Accepted	Accepted	Accepted	Partial
H6	PMM -> BEN	Accepted	Accepted	Rejected	Rejected	Rejected	Rejected	Rejected	Partial
H7	CM -> BEN	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive
H8	UPV -> BEN	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected
H9	DQ -> BEN	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive
H10	FIT -> BEN	Accepted	Accepted	Accepted	Accepted	Rejected	Rejected	Rejected	Partial
H11	TMSV -> ALG	Accepted							Accepted
H12	TMSV -> AR	Inconclusive							Inconclusive
H13	TMSV -> CM	Inconclusive							Inconclusive
H14	TMSV -> UPV	Accepted							Accepted
H15	AR -> TS	Inconclusive							Inconclusive
H16	CM -> UPV	Inconclusive							Inconclusive

22.11 Results and findings

Construct validity and reliability testing resulted in the removal of the following constructs: Data quality (DQ), adequate resources (AR) and effective change management (CM). A new construct was created (Collaboration) but through additional factor analysis testing the construct was removed. The final revised model consisted of seven independent variables (TMSV, TS, FIT, PMM, ALG, REQV and UPV) and one dependent variable (BEN).

Normality analysis concluded that top management support (TMSV) was the only construct that was normally distributed. Top management support (TMSV) showed a strong correlation with all other constructs (both the dependent and independent variables). This supports the hypotheses. TMSV, TS, FIT, PMM and ALG showed strong correlation with BEN. REQV and UPV did not show any correlation with BEN. ALG had the strongest correlation with BEN followed by FIT, PMM, TMSV and TS respectively.

Top management support showed very strong positive correlation with appropriate team skills (correlation coefficient = 0.492). This could imply that top management plays a pivotal role in hiring and retaining the appropriate resources with the appropriate skill sets as mentioned by Kulkarni and Robles-Flores (2013). A strong positive correlation was shown between top management support and the alignment of BI with the business objectives (correlation coefficient = 0.381). This could imply that the more top management supports BI within an organization, the closer BI works with the broader business environment. This will result in increased alignment between BI and the business objectives. This could also explain the positive correlation (correlation coefficient = 0.351) between top management support and user participation as a closer relationship between BI and the business users will result in increased user participation. The results show that strong BI support by top management will increase realized BI net benefits (correlation coefficient = 0.346).

Appropriate team skills showed a very strong positive correlation with BI technology fit for the business (correlation coefficient = 0.481). This implies that the BI technology is only fit for the business if it is maintained and operated by resources with the appropriate skill sets.

Implementing a BI technology without having the appropriate resources to maintain the technology will result in failure, i.e. the BI net benefits will not be realized. Appropriate team skills also showed a strong positive correlation (correlation coefficient = 0.345) with alignment between BI and the business objectives. Having an experienced resource that understands both the BI- and business landscapes will increase alignment between BI and the business.

Incremental project management methodology showed a strong positive correlation (correlation coefficient = 0.430) with BI technology fit for the business. This could imply that the implementation of the BI technology is more likely to be successful when an incremental approach is followed. This will increase technology fit for business requirements due to the more successful implementation. Alignment between BI and the business objectives showed a very strong positive relationship with BI net benefits (correlation coefficient = 0.497). This implies that when BI understands and manages the business objectives appropriately, it will result in increased realized BI net benefits.

Moderators were split into groups. Industry and size relate to the organization. Role, experience and education relate to the individual respondent. The Man-Whitney U test confirmed that individuals did not show any bias in terms of their role, experience or education when answering the questions. This test also confirmed that the industry of the respondent and size of the organization that the respondent work in do not impact the way that the questions were answered.

The results show that for resources working within the IT industry, top management support does not influence BI net benefits. However, for the non-IT industry, top management support does influence the relationship. This could imply that in the non-IT industry BI needs the conscious support of top management for it to realize net benefits, where in the IT industry this support is naturally provided. There is thus a bigger drive required from top management to realize BI net benefits within non-IT organizations.

Appropriate team skills shows a positive correlation with BI net benefits for the non-IT industry but not for the IT industry. Resources with the appropriate technical skills are naturally hired within the IT industry. This relationship could be seen as a given. In the non-IT industry resources with a mix of both BI and business knowledge are hired, i.e. possibly not as technically strong as BI resources hired within the IT industry. BI technology fit for the business shows a strong correlation with BI net benefits for the non-IT industry but not for the IT industry. As the IT industry employs more technically inclined resources, the appropriate fit of the technology could be seen as less influential than within the non-IT industry, as these organizations have the resources to deal with the inadequacies or challenges of the BI technology fit.

Smaller organizations showed that top management support and appropriate team skills do not influence BI net benefits whereas in larger organizations they do. Smaller organizations have a more flat structure with less hierarchy. This could explain why top management

support is less influential as top management could potentially form part of the operational team, i.e. expected to manage day-to-day tasks. In smaller organizations resources perform multiple roles and functions where in larger organizations roles are more specialized and specific. This could explain why for larger organizations the influence of appropriate skills on BI net benefits are more influential as BI resources are seen as specialized within their function.

BI developers perceived appropriate team skills to not influence BI net benefits. This could be due to BI skills perceived as being a given for BI developers. Experienced resources also perceived appropriate team skills to not influence BI net benefits. The same argument could be made as for BI developers, as that the appropriate skills are seen as a given for more experienced resources. Postgraduate resources did not perceive BI technology fit for the business to influence BI net benefits. Undergraduates did perceive the relationship to be important. This could imply that undergraduates need to be guided more by the technology to realize BI net benefits than would be the case for postgraduate resources. For example, postgraduates can extract data, analyse and interpret results, and predict future scenarios while undergraduates need all or some of this functionality to be provided within the BI technology.

Single regression analysis aligns to the results of the correlation analysis conducted. TMSV, TS, FIT, PMM and ALG all showed to have an influence on BEN. ALG had the strongest influence on BEN followed by FIT, TMSV, PMM and TS respectively. This implies that if BI does not align to- and meet the needs of the business objectives, the BI net benefits as determined by the business will not be realized. REQV and UPV did not show to have any influence on BEN. This aligns to the results of the correlation analysis. It could be argued that well-defined business requirements, as well as user participation are perceived to be included in alignment between BI and the business objectives. For example, strong alignment between BI and the business objective will only be achieved if the business requirements are properly documented. Alignment also requires the participation of users with BI to document and realize the business objectives.

Multiple regression analysis, which shows the relationship of an independent variable on the dependent variable while taking the other independent variables into account, showed that only ALG and FIT had an influence on BEN. These variables only explain 33% of the variance in the data. The other 67% of the variance could be explained by missing mediator variables as per the Wixom and Watson model (Figure 4). These variables include organizational-, project- and technical implementation success.

Figure 14 shows the final model. Variables removed after factor analysis was conducted are not presented on the model. The values represent the Spearman's rank correlation coefficient values as per the correlation analysis conducted.

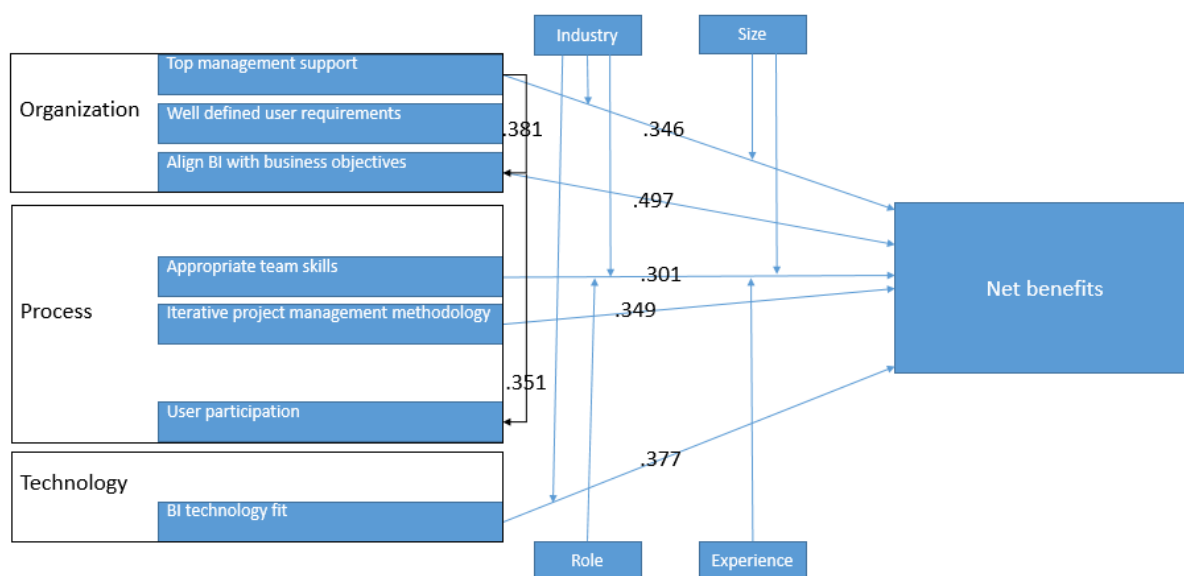


Figure 14: Final model

23 Qualitative analysis and findings

As mentioned in section 21.5 (Strategy) the results from the quantitative study will be validated by conducting semi-structured interviews with BI professionals. The following questions were compiled based on the results of the quantitative analysis and findings.

23.1 Semi-structured interview questions

The following questions were used for the semi-structured interviews with BI professionals. Interview participants were asked to comment on each of the questions.

1. How would you define data quality, adequate resources and effective change management? Do you feel that these factors influence BI net benefits and how these benefits can be realized?
2. Top management support impacts (1) alignment between BI and the business objectives and (2) user participation. Would you agree with this statement? Please elaborate on your response.
3. The below list are factors that influence BI net benefits, from most influential to least influential. Do you agree with this sequence? Please elaborate on your response.
 - a. Align BI with business objectives.
 - b. BI technology fit for the business.
 - c. Incremental project management methodology.
 - d. Top management support.
 - e. Appropriate team skills.
4. Would you agree with the below statements? Please elaborate on your response.
 - a. More top management support is required within the non-IT industry than the IT industry, to drive BI within these organizations.

- b. The IT industry tends to hire BI staff with the appropriate BI skills. In the non-IT industry, resources with mixed skills sets are hired to fill a position within the BI team. Alternatively, internal resources from the business-side are asked to fill positions within the BI team.
- c. Resources within the non-IT industry need more guidance from the BI technology than resources within the IT industry, i.e. the technology does not need to be a perfect fit to realize BI benefits within the IT industry.
- d. Top management support is less influential to realize BI net benefits in smaller organizations due to the flat management and organizational structure.
- e. Roles and responsibilities are more specialized within a larger organization.

23.2 Demographics of participants

Five participants were interviewed to validate the results from the statistical analysis. These participants all completed the survey and thus contributed to the statistical results. Table 44 shows the demographics of these participants.

Table 44: Demographics of participants

Code	Industry	Company size (# employees)	Role	Experience (years)	Education
P1	Information technology	> 1000	BI architect	> 20	Diploma
P2	Financial services	> 1000	BI analyst	11 to 20	Honours
P3	Retail	201 to 1000	BI developer	6 to 10	Honours
P4	Information technology	21 to 50	BI developer	11 to 20	Honours
P5	Information technology	> 1000	BI developer	6 to 10	Honours

23.3 Data quality

The majority of participants mentioned that data quality is defined by how accurate the data is. The data in the source system needs to be reflected by the BI reporting platforms. It needs to be consistent. Users should be able to trust the results they receive. P2 said that *“Data quality for us in the finance industry is critical. Each decimal value needs to be accurate and as per the source system”*. P3 agreed by saying that *“The actual accuracy of the data is important especially free-text fields”*. P4 added that there should be no duplication of data in the data warehouse. Users should have one version of the truth. He said that *“Data quality for me is that you don’t have any duplicates in your dimensions. So one thing means one thing. It needs to be accurate”*. P5 agreed with P4 about data consistency, i.e. one version of the truth and said *“When I produce insights it needs to be accurate. It needs to be consistent across reporting platforms and align to what the source says. Your transformations on the data from source to BI need to be the right transformations”*.

P1 had a slightly different view to those of the other participants. He mentioned that data quality should be defined by the value it brings to the business. He mentioned that *“The only way that quality can be defined is by the end user. If the information extrapolated from the data is useful and adds value to realising the organisations strategic objectives, we can surmise that the quality of the data is good”*. In addition, he also mentioned that poor data

quality is useless and ultimately costs the organization money. He said *“Since it cost resources to create the data, we can follow the logical assumption that the expenditure to create low quality data is an unnecessary expense, and in this way BI can actually become a liability to the organisation”*.

Data quality, according to the participants, can thus be defined as (1) The data is accurate and reflects the data in the source system and (2) The data is used to add value to the business. This differs to the questions posed in the survey which was (1) A complete data dictionary (definition list) exists for Business Intelligence fields, (2) The data sources used to feed the Business Intelligence system are diverse and (3) Minimal transformation is required on source system data. A data dictionary, diverse source system and minimal transformation of data were not mentioned when interviewing participants. This could explain why data quality as a construct was removed after factor analysis.

23.4 Adequate resources

BI needs to deliver on the user and business expectations. P1 said that it *“...is the responsibility of IT (including BI) to enable business to realise their strategic objectives and deliver business value”*. P4 agreed with the views expressed by P1 and mentioned that *“It is all relative. I think if business is happy with BI delivery and turnaround time we could say the team has adequate resources. But it’s tough to say. Sometimes you do have adequate resources. They are just lazy and don’t deliver”*.

Some participants argued that adequate resources is synonymous with adequate skills. This includes skills beyond technical. P2 said *“It is also about understanding what we are doing as a team and trying to achieve. It is also about skills. Not just technical. It doesn’t help you can code out of your ears but you do not understand the business and do not fit in culturally with the team”*. P5 mentioned that they have adequate resources in the team based on their skills. He said the following about his team: *“They have solid domain knowledge to bring BI and business skills together. We also have years of experience which makes us competent in delivering projects. We have line of sight of the future and we can accommodate for change and incoming requests”*.

P3 said that the team can only have adequate resources if it is big enough to split into project- and support resources. For him the number of resources is thus important in defining adequate resources. He said that *“I am the only guy developing reports in the team. In BI I feel you have a support component and a development component. I feel BI teams need to be split into those functions. Resources should not do both. If they do both, you don’t have adequate resources. You will have increased productivity if you can split the team into support and development”*.

Participants’ thus defined adequate resources as (1) BI delivers on business expectations, (2) BI has the appropriate skill sets and (3) BI needs to have enough resources, i.e. headcount. Only “BI needs to have enough resources, i.e. headcount” aligned to one of the questions

posed in the survey, i.e. The Business Intelligence team has enough team members to get work done. The other questions asked in the survey were (1) The Business Intelligence team is properly funded and (2) The Business Intelligence team is provided with enough time to complete their tasks. These did not match the results from the interviews conducted. This could explain why adequate resources as a construct was removed after factor analysis was conducted.

23.5 Effective change management

Proper handover and training can be used to define effective change management. P2 added that these training sessions should not just be once-off after the project was delivered. It needs to happen regularly after delivering until the business is comfortable with the changes. She said *“You need to have regular meetings with the business to tell them this is what is changing, these are the reasons why, etc. Where we fail in our approach at times is that we do not have follow up meetings. We just have initial handover meetings and leave it at that”*.

P3 agreed with P2 and added that a business champion with the ability to influence others is required for the change to be effectively managed. He said: *“The proper training and handover needs to be in place. You also need a business champion with authority or power which will take ownership of changes made, for example new features released or new projects completed”*. P4 added that documentation should form part of the handover and training. He mentioned that *“You need proper training and documentation for it to be effective”*.

P1 did not define effective change management but rather mentioned that it should form part of IT governance. He said *“Governance is the internal checks and balances in an IT department that allows for the effective enablement of business. Without governance there is no supporting framework within which IT can fulfil its enablement mandate”*. P4 and P5 both referred to measurements that need to be in place and met. P4 said that *“If you get too many change requests after the project was delivered or users don’t know how to use it then I would say you did not have effective change management”*. P5 agreed and said *“You need to put in measures before a project starts then measure the impact of the project using those measures after projects go live”*.

Participants defined effective change management as having proper handovers, training, documentation and a business champion. This does align to the questions posed in the survey which asked about user involvement and training. User involvement should possibly have been measured with questions about efficient handovers and having a business champion post-implementation. This could explain why effective change management was removed as a construct after factor analysis was conducted.

23.6 Top management support

All participants agreed that top management influences both alignment between BI and business objectives as well as user participation. Participants, in addition, agreed that top

management can enforce certain behaviour upon users. P2 said *“Top management at times need to force users to adopt things. Top management needs to make this part of their performance management contract”*. P3 mentioned *“Users can be told that this is part of your job or this is what you will be measured on”*. P4 agreed by saying *“And top management can tell users to make use of BI to make decisions. So they influence their participation. They can force users to make data-driven decisions based on BI”*. P5 added that *“...if the top guys give the orders then you need to follow”*.

P4 and P5 both mentioned that without top management support, BI will be working within a silo and will not align to the needs of the business. P4 said *“Top management needs to incorporate BI in the strategy sessions so that BI can align to the business objectives. Otherwise BI will just be on their own mission and not really do what business requires”*. P5 added that *“if you don't have their support you pretty much just doing your own thing”*. He also mentioned that top management can remove hurdles for BI which is critical for success.

Participant feedback thus aligned to the results from the statistical analysis. They all agreed and provided reasons and definitions why they felt top management influences alignment between BI and business objectives, as well as user participation.

23.7 Ranking of critical success factors

The majority of participants did not agree with the ranking sequence presented to them, except for P5. Top management support and alignment between BI and the business objectives were regarded as the top ranked critical factors based on participant feedback. P1 said that *“Without support there is no reason for BI, since there is no raison d'être”*. P2 agreed by saying *“If you don't have their support it doesn't matter what you do, BI will fail”*. P3 added that *“You need their buy-in for BI to succeed. BI needs to align to their strategy and goals”*. P4 mentioned that by showing the value that BI can deliver, more resources and budget for BI can be obtained. He said *“Top management support is critical. If you don't have that you don't get budget or resources. The more BI delivers the more top management support you will get. The more resources you get”*. P5 agreed with P4 in terms of showing BI value by saying *“...you need to show constant value”*.

Alignment was regarded as the second most important factor. P1 mentioned that BI needs to contribute to the strategic objectives set by the business. P2 said there needs to be alignment between output and expectation. She said *“What business expected is what BI should deliver”*. P4 mentioned that time and money will be wasted without proper alignment. He said *“Otherwise you could build something that in 6 months won't be required anymore”*. P5 mentioned that top management sets the objectives and that *“BI needs to deliver on these objectives”*.

Participants agreed that top management support is the most important critical success factor. This agreed with literature (Yeoh & Koronios, 2010) but not with the results from the

statistical analysis. The rest of the sequence matched between statistical results and participant feedback.

23.8 Moderator feedback: Industry

Proposition 1: More top management support is required within the non-IT industry than the IT industry, to drive BI within these organizations.

Participants responded with mixed responses. P1 and P4 did not agree with the proposition. They said the return on investment (ROI) and value derived from BI are key factors. P1 said *“No, management support and buy-in is achieved by showing the ROI of BI initiatives. The ROI effort is the same irrespective of industry. Top management is interested in showing profit and if BI can help achieve this they would support the initiative”*. P4 mentioned that the value realized from BI is critical. He said *“I don’t fully agree with this. I think your top management just needs to appreciate the value of data. I don’t think the industry really is a factor”*.

P2, P3 and P5 agreed with the proposition. P2 mentioned that explicit support from top management is required in non-IT industries. She said *“In a non-IT company you need to motivate why you should include BI as part of a project”*. P3 echoed that the value of BI is better understood within the IT industry. He said *“In IT companies the understanding of IT tools and their benefits are better understood. In non-IT companies this is not the case. They don’t always see the benefits of IT tools”*. P5 had a very similar opinion in terms of the value of BI as per P3. He said *“In the non-IT industry it feels like people don’t understand the value of BI”*.

Proposition 2: The IT industry tends to hire BI staff with the appropriate BI skills. In the non-IT industry, resources with mixed skill sets are hired to fill a position within the BI team. Alternatively, internal resources from the business side are asked to fill positions within the BI team.

The majority of participants, excluding P4, agreed that the IT industry tends to hire BI staff with the appropriate skills. P1 said that this is due to *“BI is not well understood as a specialised area outside the IT industry”*. P2 said that having a mixed skill set and not being specialized in BI can be both *“a benefit and other times a detriment”* to the team. P3 said that this is happening at his firm. He added *“The previous BI developer actually came from the business side. He was good with Excel. So he joined the BI team”*.

P4 disagreed with the proposition. He said hiring staff with the appropriate skills are not dependent on the industry but rather the manager. If the manager comes from a BI background she will tend to hire BI resources with the appropriate BI skills. He mentioned that *“I think it depends more on the manager hiring the resources. If this resource is more technical she will tend to hire more technical resources. And vice versa. I don’t think industry plays a role”*.

Proposition 3: Resources within the non-IT industry need more guidance from the BI technology than resources within the IT industry, i.e. the technology does not need to be a perfect fit to realize BI benefits within the IT industry.

All participants agreed or partially agreed with this proposition. P1 added that technology fit is more related to users understanding than actual technical incapability of the technology. He said *“Technology is seldom hampered by native capability, but rather by the end-users understanding of this capability”*. P2 mentioned that in the IT industry, resources have a can-do attitude to make the BI technology work. She said *“100% agree with that. In fact in IT industry there is no like it doesn't work type of problem. There is only find a way to make it work”*. P5 agreed with P2 about the attitude and finding a way to make things work. He said *“It seems like people in IT is more chilled about stuff not being perfect. They make a plan and work around it”*. P3 partially agreed and added that it all depends on the individual. He said *“Those that are more technically clued up will make it work, regardless”*.

23.9 Moderator feedback: Company size

Proposition 1: Top management support is less influential to realize BI net benefits in smaller organizations due to the flat management and organizational structure.

Most of the participants agreed with this proposition. The only participant who disagreed was P1. He said top management is influential to realize BI net benefits regardless of the size of the company. He said *“Top management is the primary driver, and their influence is total since they drive business. The structure below them determines how their directives are executed, but does not diminish their influence. If you turn the steering wheel, you turn the vehicle, irrespective of whether you are driving a car or a bus”*.

P2 mentioned that in smaller organizations top management is closer involved with day-to-day business activities, which include BI. She said that due to this top management *“probably needs to drive BI benefits less”*. P3 agreed with P2 and said *“You have less people and they are closer together in small firms. So it is easier to get top management support due to the flat structure”*. P4 mentioned that top management has a closer relationship with employees in smaller firms. Their support is thus implicit. He added *“Yes in small organization you can go to the CEO directly and just talk to her about what you doing. In larger organizations you don't even know who the executives are sometimes”*. P5 mentioned that top management is more involved in smaller organization due to increased transparency.

Proposition 2: Roles and responsibilities are more specialized within larger organization.

All participants agreed with this proposition. P1 mentioned that *“Roles and responsibilities tend to be more clearly defined in large organisations since better governance is needed to manage large organisations”*. P3 said that corporates have more financial capital than small firms and therefore they are able to hire *“more specialized resources for specific tasks”*. P4 mentioned that due to lack of resources in small firms, resources are required to execute

various tasks. He said that *“In large corporates you have a spec and you stick to it. In smaller firms you do a bit of everything as you don’t have loads of people”*.

24 Discussion

A literature study found that the ten most prominent critical success factors to achieve BI net benefits are: Top management support, appropriate team skills, BI technology fit for the business, incremental project management methodology, align BI with business objectives, well defined business requirements, user participation, data quality, effective change management and adequate resources. The statistical analysis concluded that data quality, effective change management and adequate resources should be removed as critical success factors. Semi-structured interviews revealed that participants have a different definition of these factors as opposed to the questions stated in the online survey. This mismatch in definitions resulted in the three factors being removed from the study.

The study found that alignment between BI and the business objectives has the biggest influence on BI net benefits. This was followed by BI technology fit for business, incremental project management methodology, top management support and appropriate team skills. Well defined business requirements and user participation did not have an influence on BI net benefits at all. The semi-structured interviews however revealed that top management support should be considered the most influential critical success factor. This observation aligned to literature. Literature revealed that top management has an influence on both alignment between BI and the business objectives as well as user participation. This was validated through the interviews with participants. The statistical results however show that top management support has an influence on all other critical success factors.

Participants partially agreed that more conscious top management support for BI is required in the non-IT industry compared to the IT industry. There was majority agreement among participants that resources with the appropriate skills are naturally hired within the IT industry. In the non-IT industry resources with mixed skills are hired to fill BI positions. The interviews revealed that resources within the IT industry do not require the BI technology to be a perfect fit to realize BI net benefits. Workaround solutions can be implemented to achieve BI net benefits. Explicit or mindful support from top management is required within larger organizations. Due to the flat organizational structure this support is naturally provided to BI in smaller organizations. Roles and responsibilities were determined to be more specialized in larger organizations than in smaller ones. Resources are required to fulfill multiple functions in smaller organization.

25 Conclusion

25.1 Review of findings

The purpose of this study was to determine the influence of BI CSFs on BI net benefits. In addition the study also determined why these factors are important, what the

interrelationships are between the CSFs and how moderating variables affected the relationships between BI CSFs and BI net benefits.

A deductive approach was followed. A conceptual model was developed using literature which indicated the ten most prominent BI CSFs and their relationship with BI net benefits. The conceptual model also included moderating variables. Literature guided the measures to be used for both the CSFs and BI net benefits and a pilot study resulted in the instrument being approved. An online survey was used to gather data for the statistical analysis. These results were validated by conducting semi-structured interviews with BI professionals who completed the online survey.

The study showed that alignment between BI and business objectives, BI technology fit for business and incremental project management methodology ranked as the most influential CSFs. Interviews however contradicted this order and ranked top management support as the most influential CSF to realize BI net benefits. This aligned to literature.

Top management support showed an influential relationship with all other CSFs. Industry was found to moderate the relationship between top management support, appropriate team skills and BI technology fit for business, with BI net benefits. Company size moderated the relationships between top management support and appropriate team skills, with BI net benefits.

25.2 Implications and contributions

Organizations need to have top management support in order for BI net benefits to be realized. Without this support, BI will work in isolation and will not align to the strategic goals as set by top management. Top management is also able to provide resources, which include people and budget, to BI teams which increases the likelihood of realizing BI net benefits. BI needs to frequently show that it is adding value. This will increase the level of top management support.

BI needs to align to the objectives as set by the business. The objectives are determined by the strategy set by top management. BI only adds value if it delivers on the business objectives. The BI technology needs to be a fit for the business. The better the fit, the more the likelihood of achieving BI net benefits. A perfect fit is not always necessary to realize BI net benefits. Resources with the appropriate skills are able to add value even when the technology is not a perfect fit. Following an incremental project management methodology will increase the likelihood of BI success as value is delivered more frequently. This in turn will increase top management support as they are presented with delivered pieces of work on a more regular basis. Following this methodology will also allow BI to work on relevant work as the business can dictate the direction of a project through more regular engagement.

Top management within the non-IT industry needs to provide more explicit support for BI. They also need to focus on hiring the appropriate BI resources within this industry. Lastly,

the non-IT industry needs to prioritize the implementation of a BI technology that fits the business perfectly as this will increase BI net benefits realized. Top management within large organization needs to drive BI more explicitly to extract maximum return on their investment.

25.3 Limitations and future research

The usable sample was 109 online survey responses. A larger set of sample data could possibly have yielded different results. Data analysis resulted in data quality, adequate resources and effective change management to be removed from the study. The influence of these CSFs on BI net benefits could thus not be tested. Future studies should change the research instrument measurements for these CSFs. It would be interesting to see if these CSFs would still be removed if their measurements were changed as per the definitions provided by the participants when conducting the semi-structured interviews.

It should be noted that not all the independent and dependent variables were normally distributed. This is typically required when conducting regression analysis. This could skew the results obtained and should be noted as a limitation of this study. The model that was tested did not have any intermediate variables. By adding these variables, the results could have differed from those determined in this study. Due to time constraints, only five participants were interviewed to validate and elaborate on the results from the statistical analysis. It is recommended that 10 to 15 participants should have been interviewed.

Future studies should change the research instrument to align to the definitions provided by the participants for the various CSFs. Additional intermediate variables should also be added to the conceptual model. A larger sample size should be gathered. Similar studies in countries with the same economic climate as South Africa could be conducted. It would be interesting to see how the results compare between these studies. Future studies of this nature could focus on resources other than BI professionals. These could include top management, BI researchers or change management resources.

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27 Appendix A - Online survey



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Please answer the following questions by reflecting on your most recent experience of Business Intelligence in your organisation. The survey will take about 10 minutes to complete.

1. What industry do you work in?

Insurance Banking Investments Retail Information technology Other (Please specify): _____

2. How many employees does your company employ?

<= 5 6 to 20 21 to 50 51 to 200 201 to 1000 > 1000

3. What is your role within the organization?

BI developer BI analyst BI project manager BI manager Data user Senior management Other (Please specify): _____

4. How many years of Business Intelligence experience do you have?

< 1 1 to 5 6 to 10 11 to 20 > 20

5. What is your highest level of education?

Matric Higher certificate Diploma Bachelor's degree Honours Masters PhD Other (Please specify): _____

6. Top management encourages the use of Business Intelligence.

Strongly Disagree Disagree Neutral Agree Strongly Agree

7. Top management sponsors Business Intelligence initiatives.

Strongly Disagree Disagree Neutral Agree Strongly Agree

8. Top management is committed to hiring employees with the appropriate Business Intelligence skills.

Strongly Disagree Disagree Neutral Agree Strongly Agree

9. Top management is committed to retaining employees with the appropriate Business Intelligence skills.

Strongly Disagree Disagree Neutral Agree Strongly Agree

10. A complete data dictionary (definition list) exist for Business Intelligence fields.

Strongly Disagree Disagree Neutral Agree Strongly Agree

11. The data sources used to feed the Business Intelligence system is diverse.

Strongly Disagree Disagree Neutral Agree Strongly Agree

12. Minimal transformation is required on source system data that feed Business Intelligence.

Strongly Disagree Disagree Neutral Agree Strongly Agree

13. The Business Intelligence team is properly funded.

Strongly Disagree Disagree Neutral Agree Strongly Agree

14. The Business Intelligence team has enough team members to get work done.

Strongly Disagree Disagree Neutral Agree Strongly Agree

15. The Business Intelligence team is provided with enough time to complete their tasks.

Strongly Disagree Disagree Neutral Agree Strongly Agree

16. Members of the Business Intelligence team have sufficient technical skills.

Strongly Disagree Disagree Neutral Agree Strongly Agree

17. Members of the Business Intelligence team have sufficient soft skills.

Strongly Disagree Disagree Neutral Agree Strongly Agree

18. Members of the Business Intelligence team have sufficient analytical skills.

Strongly Disagree Disagree Neutral Agree Strongly Agree

19. The Business Intelligence technology works well with other existing technologies.

Strongly Disagree Disagree Neutral Agree Strongly Agree

20. The Business Intelligence technology is scalable.

Strongly Disagree Disagree Neutral Agree Strongly Agree

21. The Business Intelligence technology is flexible.

Strongly Disagree Disagree Neutral Agree Strongly Agree

22. The Business Intelligence team uses an incremental delivery approach.

Strongly Disagree Disagree Neutral Agree Strongly Agree

23. The Business Intelligence team does not make large scale changes when implementing solutions.

Strongly Disagree Disagree Neutral Agree Strongly Agree

24. The Business Intelligence strategy aligns to the corporate strategy.

Strongly Disagree Disagree Neutral Agree Strongly Agree

25. There is a clear link between Business Intelligence projects and business objectives.

Strongly Disagree Disagree Neutral Agree Strongly Agree

26. The Business Intelligence requirements are properly documented.

Strongly Disagree Disagree Neutral Agree Strongly Agree

27. The Business Intelligence requirements are agreed upon before the Business Intelligence projects start.

Strongly Disagree Disagree Neutral Agree Strongly Agree

28. Business Intelligence team members and users work together on Business Intelligence projects.

Strongly Disagree Disagree Neutral Agree Strongly Agree

29. Users are assigned full-time to certain Business Intelligence project tasks.

Strongly Disagree Disagree Neutral Agree Strongly Agree

30. Users perform hands-on activities during Business Intelligence projects.

Strongly Disagree Disagree Neutral Agree Strongly Agree

31. Users are involved within the Business Intelligence change management process.

Strongly Disagree Disagree Neutral Agree Strongly Agree

32. The Business Intelligence team provides users with sufficient training and support after Business Intelligence delivery.

Strongly Disagree Disagree Neutral Agree Strongly Agree

33. Business Intelligence enhances the organization's decision making capabilities.

Strongly Disagree Disagree Neutral Agree Strongly Agree

34. Business Intelligence increases the organization's ability to predict future scenarios.

Strongly Disagree Disagree Neutral Agree Strongly Agree

35. Business Intelligence reduces the organization's time it takes to make decisions.

Strongly Disagree Disagree Neutral Agree Strongly Agree

36. Business Intelligence increases the organization's productivity.

Strongly Disagree Disagree Neutral Agree Strongly Agree

28 Appendix B - Interview consent form



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02 April 2017

Dear Sir/Madam,

I am a student enrolled in the Masters programme of the Department of Information Systems at the University of Cape Town. As part of the course curriculum I am required to submit a technical research report.

The purpose of this study is to measure the influence of business intelligence critical success factors on business intelligence net benefits. The effect of moderating variables will also be measured. The interrelationships between the critical success factors will be explored. The reasons why business intelligence critical success factors are important to realize net benefits will be determined.

The survey will take approximately 10 minutes to complete. A takealot.com gift voucher to the value of R1000 will be given to a randomly selected participant once the survey period has closed. You will not be requested to supply any identifiable information as part of the survey. At the end of the survey you will be redirected to a separate portal. If you wish to enter the lucky draw for the takealot.com gift voucher you can enter your email address on the portal. The winner of the lucky draw will be emailed with the voucher code which can be redeemed from the takealot.com website. Instruction to redeem the gift voucher will be sent with the voucher code to the winning participant.

This research has been approved by the University of Cape Town's Commerce Faculty Ethics in Research Committee. Your participation in this research will be greatly appreciated. Participation is entirely voluntary and all information will be treated as confidential and used solely for the purpose of this study.

The findings of this research study will be compiled in a report that will be presented to the University of Cape Town for academic purposes. Participants' details will not be published as part of the report and all participants will remain anonymous.

By participating in the survey you are providing the researcher consent to analyse your results for this study. Thank you for your time and participation.

Sincerely,

Signed by candidate

Signature Removed

Signed by candidate

Signature Removed

Tiaan de Jager

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