A TOOL TO ASSESS THE SUCCESS OF BUSINESS INTELLIGENCE IMPLEMENTATION WITHIN FREE STATE GOVERNMENT DEPARTMENTS: TASK TECHNOLOGY FIT PERSPECTIVE

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Dedication

This dissertation is dedicated to my beloved, wise, strong, virtuous and respectable Mother.

Mother – you are my world and a pillar of an undefeatable strength!

--Tanki

Declaration

I, **Tanki Eusebia Masekoala Moloabi** (student number), hereby declare that this research project submitted to the Central University of Technology, Free State for the Degree **Masters In Information Technology**, is my own independent work; and complies with the Code of Academic Integrity, as well as other relevant policies, procedures, rules and regulations of the Central University of Technology, Free State; and has not been submitted before to any institution by myself of any other person in fulfilment (or partial fulfilment) of the requirements for the attainment of any qualification.

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Tanki Moloabi.

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Abstract

This study employed an information systems (IS) framework development based on a case study. Data collected using a questionnaire was analysed using factor analysis technique to examine the effectiveness of the widely used Vulindela System (VS) – a business intelligence (BI) technology – in the public sector, with special focus on three service-delivery-oriented government departments, namely the Treasury, Health and CoGTA in the Free State Province, South Africa. Two principal component analysis (PCA) models were built to extract latent factors capturing the weakness and strength of the VS, with the first model assessing the internal consistency and adequacy of the survey questions to measure the VS as an observable construct, and the second model is estimated based on the 12-Task Technology Fit (TTF) evaluation theoretical framework proposed by Goodhue (1995). Firstly, the evidence from the survey reveals that sizeable number of main users (about 70%) of the VS perceived the system as a: user-friendly-web-based IT system, an easily accessible, problem-solving and flexible BI tool capable of executing analytical (financial) and decision-making related tasks, amongst others. The effectiveness of the System is, however, constrained by lack of technical-know-how among most users, for instance to extract and disseminate complex information produced by the system and limited technical support to resolve network issues. Secondly, the results of the PCA models confirm that the strength of VS as a decision-making BI tool can be ascribed to its ability to perform unstructured tasks, collate quality information, enhance total productivity, whereas the operational capacity and functionality of the system is hampered by the System's inflexibility to be integrated with other IT systems, inability to facilitate new/non-routine/unstructured tasks. Finally, the results of the TTF-based PCA model show that the VS is mostly (in) directly influenced by its operational capacity and functionality features, and its shortcomings is attributable to the System's incompatibility to meet user's task profile and inflexibility to execute new task demanded. Based on these findings, the efficiency gain derived by the main users in the focal provincial departments is relatively low vis-à-vis the high cost of implementing the system. The functionality features of the existing VS technology need to be upgraded to allow, for instance, easy accessibility of reports/information with short turn-around time, performance of (un-)structured and non-routine tasks that meet the users' task profiles. Despite significant inferences produced by the two-pronged quantitative analysis by making use of a small sample, however, the robustness of the inferred results and statistical power of the structural framework will significantly improve by using a larger sample size.

List of Acronyms

ATM	Automated Teller Machines
BAS	Basic Accounting System
CoGTA	Cooperative of Governance and Traditional Affairs
DoH	Department of Health
DP	Data Processor
DSS	Decision Support System
DW	Data Warehousing
EIS	Executive Information System
FS	Free State
FSPT	Free State Provincial Treasury
HR	Human Resource
IFMS	Integrated Financial Management System
IT	Information Technology
KMO	Kaiser-Meyer-Olkin
LOGIS	Logistic Information System
MIS	Management Information System
OLAP	Online Analytical Processing
PCA	Principal Component Analysis
SCM	Supply Chain Management
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
TAM	Technology Acceptance Model
TIM	Technology Infusion Matrix
TPS	Transactional Processing System
TTF	Task Technology Fit
US	United States
VS	Vulindlela System

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CHAPTER 1: INTRODUCTION

1.1. Overview

Business Intelligence (BI) is a commonly used term for the technologies, tools, applications, best practices and processes associated with collecting, storing, using, disclosing and analysing data, and to enable access to information to improve and facilitate decision-making. Technologies are described as the key supporter of decision-making process within private and public sectors world-wide. In this context, BI is referred to as a 'grand', term that spans the people, processes and applications/tools to organise information, enable access to improve decisions and manage performance (Chandler et al., 2011).

At present, it is unlikely to find a successful organisation not using BI technology in for business operations. Information Technology tools is generally embedded into enterprise software and systems such as Enterprise Resource Planning (ERP), customer relationship management system (CRM) and Supply Chain Management (SCM). Challenges experienced by many organisation can be attributed to lack of an adequate tool to evaluate software packages and enterprise system (Ghoshal and Kim, 1986, cited in Ghazanfari 2011).

To ascertain quality service delivery to the citizens using a sophisticated information system, the South Africa's National Treasury department has invested in BI tools for deployment of the BI tools at the national and provincial level has been excruciatingly slow and fragmented. However, to expedite the use of BI tools, National Treasury tends to implement these technologies in phases as a piloted programme. Recently, the use of BI tools in the public sector, to optimise efficiency gain, enhance productivity and deliver quality services to the citizen, is gradually becoming popular. The department of national Home Affairs and the Gauteng provincial Department of Education, are a few public sectors where the BI tools are widely used.

In comparison to government departments elsewhere, in particular, those in Gauteng, that are already providing similar public services to some shareholders, the Free State government departments tend to operate their enterprise software and systems in isolation. Examples are across provincial departments to make accurate and timeous decisions, and to enhance service delivery and the overall performance of IT users. This is not designed to facilitate, for instance, unstructured and non-routine tasks. This problem is further worsened by these systems not being designed to facilitate, for instance, unstructured and non-routine tasks. Lack of integration of information systems within Free State (FS) government departments makes their decision processing lengthy and time-consuming. Measuring the effectiveness of Business Intelligence (BI) technologies within Free State government departments is therefore problematical.

Today, it is difficult to find a successful enterprise that has not employed some form of Business Intelligence (BI) technology in their business operations. BI is mostly embedded into enterprise software and systems such as enterprise resource planning (ERP), customer relationship management systems (CRM) and Supply chain management (SCM). The challenge most organisations face is lack of a tool to evaluate the BI competences of these enterprise software and systems against the organisation's decision-making processes. Most existing evaluation tools tend to focus on evaluating and selecting software packages and enterprise systems but not the intelligence criteria (Ghazanfari et al., 2011). Despite serving the same shareholders, the Free State Government Departments tend to operate their enterprise software and systems in 'silos' hence, making it difficult to implement BI tools effectively. This is further aggravated by the fact that these systems were not designed for the challenging environments (especially infrastructural) the Departments operate in Silo.

Lack of integration of Information systems within Free State government departments makes the decision-making process lengthy and time-consuming. Measuring the effectiveness of Business Intelligence (BI) technologies within Free State government departments will enable and enhance a better support to the decision makers to improve service delivery.

It is a top priority for managers to handle increasing data volume in a structured and unstructured formats available to analyst and decision makers across departments for quicker decision-making in an easy to understand formats as it is the foundation of each department. FS Departments have to realise the future growth, as need to forecast Business Intelligence (BI) employ filtering, zooming, user drill down features to improve data visualisation, and leverage on timeous information for decision-making. It is efficient tool to utilise dashboard and data analytics to transform departments' data into easy to understand reports, for improved productivity, cost-efficiency, improve corporate performance and strengthen user relationship.

1.2. Research Questions

Assessing the BI tools currently used in the FS province, in this case the Vulindlela system (hereafter VS) with special focus on three important service oriented provincial government departments, namely the Free State Treasury, provincial departments of Health and CoGTA; this study seeks to answer the following questions:

1.2.1. What is the effectiveness of the BI tools used in the provincial departments of Free State Provincial Treasury (FSPT), Free State Health (FS DoH) and Free State Cooperative Governance and Traditional Affairs (FS COGTA) in terms of task-facilitated users' experience and their performance to make accurate decisions?

1.2.2. What are the determining (observed and unobserved) factors underpinning the effectiveness of these BI tools?

1.2.3. Do the components of BI tools used in the three focal provincial departments aligns with the Task-Technology theoretical framework?

1.3. Research Objectives

The primary aim of this study was to assess the success of implementation of BI enterprise systems within FS three government departments. Furthermore, the analytical assessment in the study is guided by the following secondary objectives, which are to:

1.3.1 Examine the existing BI tools in three FS government departments: Treasury, Health, and COGTA.

1.3.2 Apply the Task-Technology Fit approach to derive and evaluate a generic framework for success of tools in support of decision-making in government departments' context.

1.3.3 Analyse BI tools in the three (3) Free State government departments

1.4. Significance of the Study

In the contemporary era, the world has become a global village largely driven by business intelligent tools. Hence, it is imperative to evaluate BI tools that are currently being utilised in the provincial departments in the Free State, given that management executives want to keep abreast of the operational capability of these tools, whether their sizeable investment provides any value-added benefit to improve the overall performance of the service-oriented departments such as human resources (HR), finance and supply chain management (SCM). In the same vein, the efficiency gain and the mode of delivery of public services using the costly BI tools is of a paramount interest to policy makers and the executive managers in provincial departments.

On the other hand, the delivery of fast and quality services is one of the top priorities (if not the main) of national government. It is imperative to evaluate the usefulness of existing BI tools across the aforementioned service oriented provincial departments, focusing on integral components, for example operational capacity and IT functionality of the system, as well as, highlighting the experience of the users of the system. Typically, deduced inferences from this type of assessment of the BI system would not only be beneficial to FS government, among other provinces, where the implementation of the BI is in a nascent phase, but also enhance service delivery and optimal productivity of users, in this study.

Against this backdrop, quantitative survey findings and empirical model factor analysis obtained from this study not only identify the weakness and strength of the existing BI tools in the provincial departments, but has also equipped the main users with rich information on the functionality and operational capacity of the BI tools. Moreover, the implication of the findings allow both the main users of the BI system and policy makers to make prompt decisions, for example on budget allocations and the often convoluted supply chain processes, which is likely to become a seamless procedure by using adequate BI tools.

In addition, complex data analysis and generation of voluminous report becomes easier, and easily assessable, if and only if, the weakness of the existing BI tools in the provincial departments are identifiable, but this type of knowledge requires a well-designed survey as well as the employment of a robust BI evaluation model such as the Task Technology Fit (TTF) theoretical framework, which is the main motivation of the present study and the novel analytical approaches employed, thus the contribution of the study to the existing literature.

1.5. Ethical Considerations

The study involved collecting data about and from the employees of the FSPT, FSDoH, FSCoGTA, the research process followed ensured sensitivity and respect of research participants and their basic human rights; in doing so, the ethical Code of the Institution CUT was followed. Firstly, ethical clearance was sought from the research office, and secondly, a letter of permission to study and conduct research and collect data was attained from the Head of the Department (see Appendix III).

1.6. Outline of Dissertation Chapters

This dissertation comprises five (5) chapters structured as follows: Chapter 1 gives an overview of the study and also justifies the rationale for undertaking the study. Chapter 2 summarises relevant and related studies and theoretical models for assessing BI's in the extant literature. Chapter 3 provides the two-pronged methodological approaches used to achieve the objectives of the study, and also outline the data collection processes. Chapter 4 focuses on data analysis and the discussion of results for both the survey method and principal factor analysis are reported and discussed. Finally, Chapter 5 considers further work and presents the conclusion of this study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to provide an historical overview of BIs, benefits derived from using BI, survey relevant literature on BIs, and identify theoretical models for evaluating BIs. The chapter, also stresses the implementation of BIs in South Africa and, specifically, the Free State Province.

Broadly, BI tools direct organisations on data monitoring and business insights generation. This enables the Free State decision makers to make more unconventional decisions to gain results. There are different types of BI, namely: business analytics and big data statistics, reporting, and dashboard that offer at-a-glance information across indicators/tasks. One of the benefits of BI is that, the system can turn information into knowledge. BI is the information at hand for making strategic decision in an organisation. The complexity of choosing the right BI tools to be used can be achieved through the BI tools such as data mining and predictive analytics, bridging the gap of integrating the silo systems to enable informed decision-making and service delivery.

2.1.1 Definitions of BI.

In practice, BI systems transcend the narrow definition elucidating the system comprising of technological tools and practices. As a multidimensional model, BI is concerned with the effective implementation of organisational practices, processes and technology to create a knowledge base that supports the organisation (Olbrich et al., 2012). The purpose of BI is to recognise information needs and processe the data gathered into useful and valuable managerial knowledge and intelligence (Pirttmaki, 2007). Besides, BI entails varying set of concepts and methods to improve business decision-making by using hypotheses, and computerised support systems. BI tools are a key enabler of the decision-making process within private and public sectors world-wide. In this context Chandler et al. (2011) emphasise that people, processes and technology are used to organise information, enable access to improve decisions and manage performance.

Dresner (1998) proposed the across-the- board definition of BI in the public writings. Up until now, there is no consensus among researchers on the accurate meaning of BI (Arnott and Pervan 2005; Pirttmäki 2007; Chee et al., 2009; Watson 2009; Foley and Guillemette 2010; Wixom and Watson 2010; Turban et al. 2011). This is unsurprising, given the nascent but evolving strand of literature evaluating BI systems (Negash 2004; Pirttimäki 2007; Jourdan et al. 2008). Indeed, Foley and Guillemette (2010) argued that the myriad of BI definitions proposed by many researchers arise from their intent to align their concept of BI in line with a particular research.

Dresner (1989) introduced the BI as an encompassing term that distinguishes a set of concepts and methods to improve business decision-making by use of fact-based, computerised support system. Ghoshal and Kim (1986) proposed the first scientific definition of BI: to maintain that as a management philosophy and tool that helps organisations to manage and refine business information for the purpose of making effective decisions. For instance, Golfaleri et al., (2004), posit BI as an efficient decision-making and analytical tool to better understand the status of the business and improve the decision-making process, in an organisation. Golfaleri (2004), perceived BI as the process of turning data into information and then into knowledge; this explains that knowledge is typically obtained about the client needs, general economic, and technology and culture trends. In another study, Ghazanfari et al. (2011) focused on the existing evaluation tools and the selection of software packages that are used in the organisations, but not the intelligence criteria within the software and applications.

The use and adoption of BI in public sector can be of great importance in improving service delivery and decision-making within the sector. Whereas Petrini and Pozzebon (2004) assert that studies of BI mostly focus on two approaches, entailing (i) the managerial with process-orientation and (ii) technologic orientation, which narrowly focuses on the set of tools to be used.

On the other hand, Ghoshal et.al (1986) defined BI from a management philosophical viewpoint, maintaining that as an IT tool, BI allows organisations to manage and refine business information and to make effective business decisions. BI produces up-date information for operative and strategic decision-making. Other scholars viewed BI as competitive intelligence and market intelligence that aim to gather and analyse useful information regarding only the external business (Sawka, 1996:47-52; Collins, 1997:14). For instance, in North America the concept of BI, according to Nelson, 2001:44) is used to refer to analysing data and information gathered from the organisation's operative information systems, using the reporting software and tools such as data mining and online analytical processing.

A common theme in the concepts of BI is that these definitions are restrictive, and narrowly focused on technology-driven data analysis and databases. In Finland on the other hand, there is a broader definition in the use of BI, which entails systematic and continuous monitoring, collection, analysis and sharing of internal and external business information (Hirvensalo, 2004; Global Intelligence Alliance, 2005).

On the other hand, Thierauf (2001) presents BI to give assistance to decision-makers to obtain a holistic view of the business environment capabilities. In addition, moreover, BI increase strategic and operational planning quality and decreases the time used for decision-making by improving and accelerating an organisational decision-making process and information management (Gilad et al., 1986; Collins, 1997). Notably, a significant goal of using BI is solely to identify threats and opportunities as well as reduce the reaction to technological crises (Thomas, 2001: 48). Conclusively, there is no universal definition for BI given that the system's domain is broad.

2.1.2 Functions of BI

By and large, BI system converts data into useful information through human analysis into knowledge. Indeed, Gilad and Gilad (1986:53) summarised the tasks of BI systems into categories, which involve: raw data collection, information gathering, analyse and share the information processed for decision-makers. In every system, an individual will require a report on every tasks performed to track the impact of the work. BI tools as business intelligence technologies retrieve, analyse, transform and report data for business. The application reads data that has been previously stored within data warehouse or data mart. BI aims to support decision-making within the organisation and improve quality of the decision to be taken, and to better service delivery.

Premised on the surveyed studies on BI, it is clear that the public sector in South Africa, needs simulations of different methodologies to evaluate and assess the BI capabilities and competencies of the work in order to accomplish their objectives and realise right decisions at the right time (Ghazanfari, 2011). Given that BIs are designed based on data warehousing

(DW), there are risks involved when applying BI to access the repository with large amounts of historical data that are directly accessed by the intended users through the multidimensional organisation of the data (Golfarelli, 2005).

In the existing BI literature, the development of BIs is based on two main approaches, namely the technical and managerial approaches. BIs use a set of approaches, namely; firstly, a technical approach that supports the process of creating an information environment, in which operational data gathered from the Transactional Processing System (TPS) and external sources can be analysed to extract business knowledge to support the unstructured decision of management. Secondly, the managerial approach that sees BI as a process in which data gathered from inside and outside the enterprise, are integrated in order to generate information relevant to the decision-making process (Petrini and Pozzebon, 2012). Indeed, anecdotal evidence posits that successful BI implementation provide information to decision makers to enable them make operational, tactical or strategic decisions and apply metrics to ensuring that organisation goals are met (Lutu and Meyer, 2008).

Generally, BI systems are used to satisfy the need of decision makers for well-organised and actual study of organisational data to better comprehend the status of the industry and improve the decision process (Golfaleri, 2004). The motive behind the development of the Business intelligence (BI) is essentially to assist business organisations to adequately disseminate and manage data-driven information for decision purposes (Ghoshal and Kim, 1986 cited in Ghazanfari 2011). BI aims to provision decision-making within the organisations and improve the quality of decision-making, better customer service or service delivery in a public sector context (Olszak, 2006:7). Also, BI is widely viewed as one of the instruments of analysing, and providing automated decision-making about business conditions, where huge databases analysis and mathematical formulae are used (Berson and Smith, 1997 cited in Ghazanfari, 2011). For instance, Oracle (2007) implemented a BI-based solution for the American Airlines in the United States (US), solely to handle a sizeable amount of complex data and also to extract intelligent information needed for the decision-making process.

Business Intelligence (BI) has been identified and rated as a key application and technology investment which has provided organisations with great value by improving their decision-making processes. Through BI system, information generated from all business activity is integrated and made accessible to strategic personnel towards business performance.

2.1.3 Historical Overview of the Development of Business Intelligence

The development of BI can be traced back to 1865, when Richard Devens coined the term by linking "business" and "intelligence" referring to the common links between bankers' decision-making in his book, *Cyclopedia of Commercial and Business Anecdotes*, of which the same name is frequently used for all corporate data-related analytic processes. In 1970, IBM and Siebel came and recognised the increasing need for fast and accurate data analysis.

The role of BI systems and their influence over organisations has been subject to change. They have evolved into solutions than can be used in strategic planning and monitoring operation (Negash and Gray, 2008). Over the years, the use of BIs has evolved from merely a technological tool to decision-making and task-processing system useful for organisations. Therefore, management of the organisation need to devise new strategies for collecting, storing, processing, analysing, and using information (William et al., 2007).

Over the past two decades, the systems supporting decision-making has evolved, since the introduction of computers into commercial initiatives in the mid-1950s for data processing (DP). Transaction processing symbolises the repetitive processing of business events and data storage that is summarised into transactional data with respect to decision-making. In the 1970s, the first versions of analytical software packages, referred to as management information systems (MIS), appeared in the market.

Gartner research was credited for using the term 'BI' in the late 80s for the recent development of BI systems supporting organisational decisions, and announced a broad category of software and solutions for gathering, consolidating, analysing and providing access to data in a way that allows enterprise users make better business decisions. However, this was not the first time the term was used but rather since 1958. In the 1990's Executive Information systems (EIS), the on-line analytical processing (OLAP) followed the scorecards and dashboards, key performance indicators and real-time alerts through business activity monitoring (Giles, 1994).

Since 1998, data storage systems and technologies have led to the creation of database management systems, a major drive by Information Technology (IT) teams working endless hours to create and deliver report and data processes. BI applications were developed for web-based BI tools to offer self-service efficiencies, better data visualisation, improved customisation and real-time data feeds. Cloud BI tool systems were offered to provide reduced storage cost and have faster and easier access to business data and insights. 'Big data' emerged, referring to the large volume of structured and unstructured data that flood a business every day. Currently organisations are searching to invest in advanced BI tools that can analyse data for insights that lead to better informed business decisions and strategies. Today, the BI tools are those most highly used as they are single system that caters for the different need of business units, so they can be used to identify problem accounts in finance, in sales departments, and can be used to forecast for the future.

Furthermore, BI tools are considered as key supporters of the decision-making process within private and public sectors world-wide. In this context, BI is a grand, predominant term that incorporates people, processes and tools to organise information, enable access to it to improve decisions and manage performance. The BI tools are much too expensive and complex at the same time. When implemented successfully, they in turn give Return on Investment to the department. In the public sector, the funding for these large projects is always the problem as IT is not considered as the core of the organisation. Even management is hesitant to spend more on IT investment (Chandler et al., 2011).

According to Hartley et al. (2011), BI plays an important role in addressing service delivery needs in the public sector, which is increasingly implementing BI technologies. In recent research reviews, there is no comprehensive list of criteria to evaluate BI. In this research, a task-technology-fit model will be used to evaluate the BI tools using the 12 dimensions/instruments (Jadhav and Sonar, 2009).

2.2 Information Systems Evaluation models

Studies on Management Information Systems (MIS) has led to the development of a wide-range of user's evaluation models to ensure the means to measure the task required are met, and how the use of the system impacts the user's performance (Goodhue, 1992). User evaluations are defined in variation and according to the context used: user attitudes, information satisfaction, management information system (MIS) appreciation, information channel disposition, value, and usefulness. Different models are used for different sectors and the problem statement to challenge. These models consist of a number of factors to measure. The empirical factors in this model are namely quality system, quality information, utilisation/intention to use, user satisfaction/performance, and the organisational impact.

2.2.1 Theoretical Models for Evaluating BIs

Information systems are used by organisations to store, filter and process huge amount of data and invest in the information technology to derive benefit from these systems. It was, therefore, important to find out the impact or effectiveness of these systems. So the measuring of the IS was seen to be of utmost importance as various systems were developed with the view to measure its achievement.

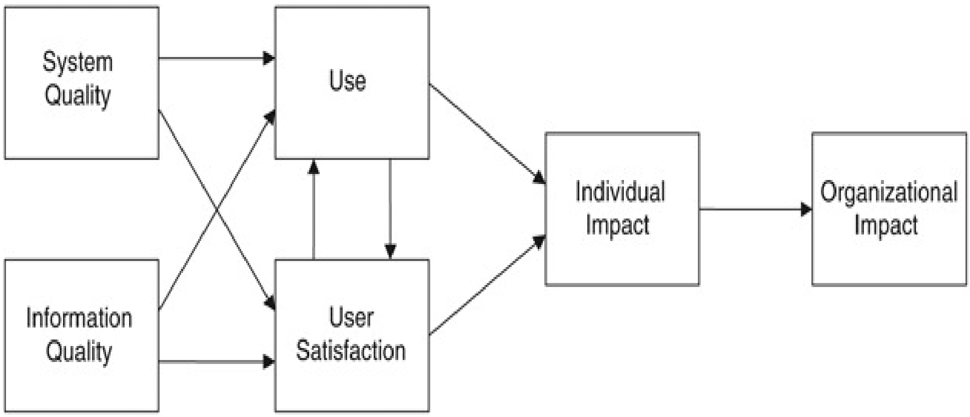

Figure 2-1: Schematic Diagram of DeLone and Mclean Framework (1992)

DeLone and Mclean (1992) developed their ideal model of IS, called the D&M model, that was used for a process/casual model and measure the quality of system, and use. The model measures technical success and information quality measures semantic success and use for user satisfaction for individual impacts. In a related study, the D&M model (2003) was used to assess the Business Intelligence System (BIS) success. In their study, theoretical TAM and TTF models were discussed, together with an integrated IT utilisation model using the path analysis that was tested. The integrated model provides extensive explanatory control of either model. The authors developed and evaluated an integrated TAM/TTF model by examining the theory underlying both models, also assessing the similarities and differences. The authors believe that the integration will be useful in understanding the software utilisation of two models overlaps, and if they are integrated they can provide a stronger model than being used as stand-alone. A number of studies have used the D&M to assess, amongst others, information system (Rai et al., 2002), tourism (Stockdale and Borovicka, 2006) and knowledge management systems (Wu et al., 2008).

Likewise, the Technology-to-Performance has been used to assess BIs. The purpose is to recognise technology utilised and the fit to the task supported for performance impact. There are number of models used to assess BI, for instance Technology Acceptance model (TAM) and, Technology Infusion Matrix (TIM) models for assessing effectiveness of systems. These tap into having proper integrated data, decisions should be made on accurate information, every user has ability to directly access source systems Manchanda et al., (2013). Technology Acceptance Model (TAM), developed by Davis (1989) was used to measure the acceptance, adoption and use of information technology. Gable et al. (2003) presented an IS impact model they developed based on the D&M model and perceived as a measurement model for a complete view of the system and successful usage in all four dimensions.

The Task-Technology Fit (TTF) model, developed by Goodhue (1995), is another commonly used theoretical model for evaluating BI. Task-Technology Fit (TTF) is defined as an established theoretical framework in the information systems that enables the analysis of theme/topic fit of technology to tasks as well as performance. The significant focus of TTF was to assess and explain information systems success and impact on individual performance (Goodhue et al., 1995). Goodhue and Thompson suggest the technology-to-performance chain, where characteristics of Information Technology, tasks and individual users explain information system use and individual performance. Studies by, for example, Goodhue and Thompson (1995), Gebauer et al. (2005), and Zigurs et al. (1998) all applied the TTF concept to Group Support System (GSS) technology and the tasks needs of a team of users.

From the perspective of information system research, technology refers to computer hardware, software, and data. Task-Technology Fit assumes that users will choose the technology based on its appropriateness for the tasks they intend to perform. This model is based on four constructs of task, characteristics, technology functionality and technology utilisation (Strong et al., 2006; Rocker, 2010), as shown in Figure 2-2.

Goodhue (1998) defines Task-Technology Fit as the stage to which a technology influences an individual in performing his or her tasks. More specifically, "it is the fit among task requirements, individual abilities and the functionality and interface of the technology" (Goodhue, 1998). TTF is a diagnostic tool for information systems. Multiple studies have confirmed the validity of the TTF in evaluating information systems in general (Goodhue et al., 1992, 1995, 1998; Angolano, 2008; Gebauer 2008).

The TTF model is used and perceived as technology that needs to be willingly accepted, as well as fit well with users and their corresponding tasks to prove its effectiveness. This study adopts the TTF perspective as it is a powerful model to analyse adoption and use behaviours of an innovative IT artefact in a specific context. TTF has been widely applied in information systems research (Lee et al., 2007; Zhou et al. 2007).

The TTF perspective is accepted as a dominant model to analyse adoption and user behaviour of an innovative IT artefact in a specific context. It is clearly indicated that, although TTF has been applied in information system research, there was a shortage of research in some areas of literature reviews remained fragmented, especially in adopting the model as a guide to conceptualise and test a TTF construct of the users' perception (Goodhue, 1998).

Finally, Zigurs and Buckland (1998) used the TTF theory in group support system environments constructed on attributes of complex tasks and their relationship with collaboration technologies. It intended not to incorporate all tasks but typically faced tasks in organisational decision-making groups. The TTF model showed five classifications of group tasks, namely: problem, simple, decision, judgment, fuzzy, and the collaborative technology support dimensions: communication, process structuring, information processing support (Gebauer et al., 2005).

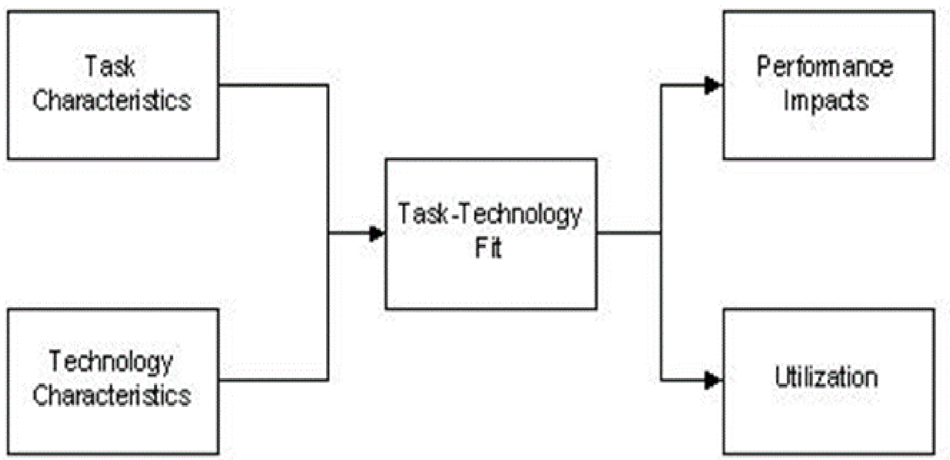

Figure 2-2: Conceptual Framework of the TTF Model.

Source: Goodhue and Thompson (1995)

2.2.2 Components of the TTF Theoretical Model

McGill et al. (2011) viewed TTF from an education perspective, to demonstrate the imperative benefit of the adequate in a learning management system (LMS) to evaluate the skills and the tasks completed by the user. This provides positive impact on user and organisation performance. Raven et al. (2010) applied the TTF model in digital video tools for oral class presentation and found a substantial fit between digital technology and improved performance of tasks. This shows how the diverse TTF model can be beneficial to different sectors to improve their performance.

According to York University (2010), the TTF theory applies IT more on the impact on individual performance and is used if the capabilities of the IT match the tasks that the user must perform. Goodhue and Thompson (1995) developed a measure of TTF that consists of 12 factors: quality, locatability, system reliability, presentation, level of detail, accessibility, assistance, ease of use/training, data quality, systems reliability, currency, and relationship with users. Each factor is measured using questions with responses on a seven-point scale ranging from 'strongly disagree' to 'strongly agree'. Goodhue and Thompson (1995) found the TTF measure, in conjunction with utilisation, to be a significant predictor of user reports of improved job performance and effectiveness that were attributable to their use of the system under investigation.

2.3 The TTF Theoretical Model

A variety of studies have confirmed the validity of the TTF in evaluating information systems (Goodhue, 1992, 1998; Goodhue and Thompson, 1995), IT security (Angolano, 2008), and mobile technologies (Gebauer, 1992). However, the TTF is often unnoticed as a theoretical construct in understanding technology impact on individual performance. TTF has been tested to be a way to measure the effectiveness in information systems. There have been different TTF models assessed and compared with other research methods, for example user evaluation. The study by Keil (1995) affirmed the TTF model is more than a user interface for information systems, more a diagnostic tool for infrmation systems and services.

Fuller and Dennis (2004) cited the TTF model as originally developed in the context of organisational systems as a way to evaluate the overall information systems and services provided in an organisation. Therefore, the technologies being somewhat limited in their flexibility was found to be a problematic factor in some studies of TTF (Goodhue, 1998:105-138). Although individuals probably had some degree of flexibility in their behaviors to perform work tasks, the technology features available to them were rather inflexible. Therefore, for performance in transaction oriented environments where the technology provides few options to support alternative methods of working on the task (i.e., limited malleability), the degree of fit is important for performance (Goodhue, 1995: 1827- 1844).

To evaluate the effectiveness of BI systems, Davis et al. (1989) developed the Technology Acceptable Model (TAM) based on the hypothesis of Perceived Usefulness (PU) which referred to the degree that system users believed that the continuous use of a particular system will enhance their overall job performance. In theory, the TAM model asserts that users could choose to adopt a specific technology based on individual cost benefit consideration. Akin to TAM, the Technology Infusion Matrix (TIM) framework has also been developed to assess the effectiveness of BI systems. Besides, TIM frameworks also evaluate some technological system to provide customer-oriented services, for example, Automated Teller Machines/ATMs (Bitner et al., 2000).

Finally, other researchers undertook to combine the TTF in the social cognitive theory (SCT) or the model of individual behaviour, that provides a personal cognition supplement to the theory of task technology fit. SCT focuses on the integrated theories to help understand knowledge management system usages from the viewpoint of organisational tasks, technology and personal view. For instance, Lin and Wang (2010) focused on the knowledge management system (KMS) utilised as the platform that provides the necessary infrastructure to implement the knowledge management processes that have become the backbone of the organisation. The authors include the major cognitive forces to empirically investigate the determinants of KMS, and also extend the TTF model using social cognitive theory.

2.3.1.1 Applications of the TTF Evaluation Framework.

The use of TTF in the BI environment has been under-researched and much of the literature remains unknown. This study assumes TTF as the guiding perspective for developing multidimensional TTF construct in BI as an established theoretical framework in information systems research that enables the investigation of issues of fit of technology to tasks as well as performance. One significant effort involved in TTF has been on individuals to assess and explain information systems success and impact on individual performance (Goodhue et al., 1995). Goodhue and Thompson proposed the technology-to-performance chain where characteristics of Information Technology (IT), tasks and individual users explain information system use and individual performance.

Although, the Goodhue and Thompson (1995) model operates at the individual level of analysis, Zigurs and Buckland (1998) presented an analogous model operating at the group level. Since the initial work, TTF has been applied in the context of a diverse range of information systems including electronic commerce systems and combined with or used as an extension of other models related to IS outcomes such as the technology acceptance model (TAM). The TTF measure presented by Goodhue and Thompson (1995) has undergone numerous modifications to suit the purposes of the particular study. Zigurs and Buckland (1998) proposed a theory of task-technology fit in the context of group support system effectiveness and found empirical support for this theory (Zigurs et al. 1999).

Table 2-1: Dimensions of Goodhue's (1995) Theoretical Model

Accessibility	Ease access to information, authorisation to access information
Accuracy	Accuracy (Correctness) of the information
Assistance	Ease of receiving helps utilising the system
Compatibility	Ease with which information from different system
Currency	How current is the information
Ease of Use	Hardware and software ease to use
Locatability	Ease of determining what information is available and where
Confusion	Understanding of the information
Meaning	Ease of determining elements within system
Representation	Presentation of information
Level of detail	Maintaining information at the right level of detail
System Reliability	System availability without errors

2.4 Application of Business Intelligence Technologies in South Africa.

It is generally accepted that BI supports decision-making at all spheres of the organisation. Management use BI to implement the realisation of the established objectives. At tactical level, BI provides a basis for decision-making optimisation and modifying documentation, financial, and technical aspects of the departments. At the operational level, BI utilises *ad hoc* analysis and reports related to daily operations (Olszak et al., 2012).

The National Treasury department has invested in BI tools to improve service delivery to the public at national and sub-national levels, but this process has been slow and fragmented. To improve usage of BI tools, the National Treasury is implementing these technologies as a piloted programme.

Fujitsu Consulting implemented a BI solution in the Translink bus company for South African Airways (Fujitsu, 2006). All this was necessitated by the requirement to handle the volume of growing data within the organisation needed to extract intelligent information for the decision-making process. The reason behind the development of these systems was to curb the time needed to generate the *ad hoc* reports and avoid errors. In other research conducted by Dawson and van Belle (2013), the focus was on extracting critical success factors for BI in the South African financial sector. Here, a framework was proposed that uses a model for data warehousing (DW), according to Wixon and Watson (2001). This model is viewed as a key enabler for increasing value and business performance.

Since BI is based on DW, there are risks involved in this process utilising BI as it is repository filled with large amounts of historical data that are directly accesses by the intended users through the multidimensional organisation of the data (Golfarelli, 2005). In South Africa, BI is used mostly in the public transportation sector (Mosebi, 2009) as well as in the South African Airways (SAA). In the public transportation sector, the BI technology has been utilised by the Department of Transport in the Free State to mitigate administrative challenges in the management of the subsidised bus companies (Interstate bus lines).

Related to this usage, Lutu and Meyer (2008) examined the use of BI in a provincial education department in South Africa, and found that the implementation significantly improved both the users' and organisational performance. These authors also confirmed the correlation between the technology fit for user requirements and successful BI adoption and usage. In the same vein, Maila (2006) conducted a case study on the Department of Water Affairs and Forestry which introduced the Performance Management and Development system during 2001, making use of TTF.

Over the years, the integrated government systems example, known as the Integrated Financial Management System (IFMS), was one of the financial management regeneration practices that aimed to improve efficiency, effectiveness, accountability, transparency, security of data management and comprehensive financial reporting. South Africa deployed the system with the intention to improve control over expenditure. Maila, Lutu and Meyer developed a conceptual model applicable to data warehousing for increasing value and business performance. It was emphasised that getting data in deliveries limited value to the business that can only be achieved when users can access and apply data and use it to make decisions, which can be realised with full value from its data warehouse.

2.4.1 Application of Business Intelligence in the Public Sector

The BI systems are used to make decisions within government departments at national and provincial levels through the reports that are produced. They are aligned with the tasks performed by individuals on different levels and responsibilities, in different section of the departments. Government department are using legacy systems that have business intelligence features within them but are not fully utilised to meet its maximum capabilities. The Information Systems (IS) includes: (i) Logistical Information System (LOGIS), (ii) Basic Accounting System (BAS) system, (iii) Personnel and Salary (PERSAL) system, and (iv) Management Information System (referred to as VULINDLELA).

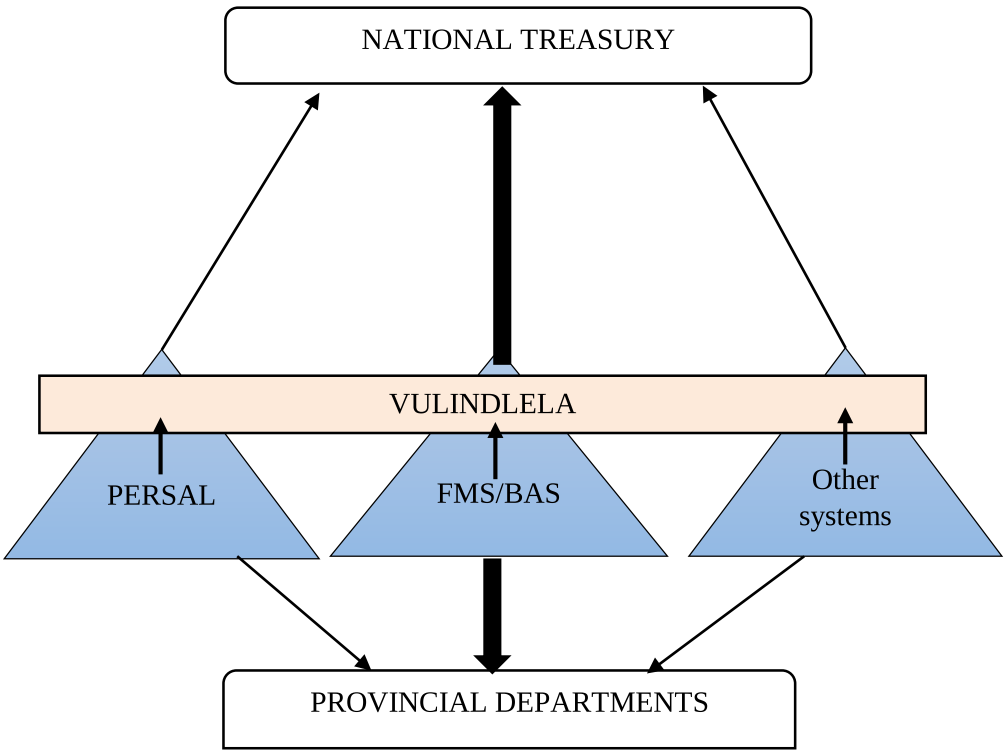

Figure 2-3: The Vulindlela System Platform.
Source: Department of National Treasury, South Africa

LOGIS is used for provisioning and administration requirements regarding the movable assets and stock control. LOGIS manages stock level, automates reordering according to stock levels, and automate inventories, chief users being the provisioning environment and the commitment of all orders placed. The main key is to manage access and profile and audit trails on all actions executed. Detailed reports, including status of orders, goods received, inventories, store statistics, approved shortages are managed, whereas the BAS system consists of a basic accounting system developed for government's basic accounting needs. It is not a fully-fledged accrual accounting system. This system has been enhanced to accommodate the other legislative prescripts such as PFMA requirements. It can now address the commitments and liabilities. BAS is used mainly for budget-blocking functionality to control and limit possible overspending, a cheque-release to avoid cheque fraud and also to standardise and enhance reporting in all levels within government.

On the other hand, the PERSAL system, is a central system designed to effectively handle administrative tasks of the public sector's payroll. PERSAL holds a database of approximately 1.1 million employees and offers a standard, *ad hoc* report. This system and Human Resources (HR) requirements are integrated into one system, but they focus more on the salary functions than on the HR functionality and data on the PERSAL is neglected and often incomplete and inaccurate. Lastly, the VS system (as MIS) (see appendix VI) is a platform that enables database warehouse of HR, finance and logistics reports. It relies on the PERSAL database and enhances access to reports, which offers high-level trends for management information.

This system was developed to increase access to relevant and up-to-date management information, and to enable more effective decision-making. This system has been improved so that now it can handle a user code revoke function, batch payment enquiries and virement/environment functions. The benefits of the Vulindlela system that has been realized are the consolidation of accounts, better cash flow management, reduction in taxation, reduction in Loans interest, transparency and trustworthiness. There were different systems and different bureaus, platforms, databases and operating systems for these financial systems. In addition, there are other leading BI tools in use as, the Microsoft SharePoint platform and the SAP systems that enable business intelligence of the tools to be fully utilised to improve performance of the organisation.

2.4.2 The Usage of BI Technology in the Free State Province

Provincial departments in Free State use BI tools as their means to support the decision-making process to improve service delivery. Since the provincial departments are emulating the national departments, there should be a uniform approach to the implementation of BI in government departments. Since the deployment of this technology is expensive, it is not easy to implement; however, they lack the expertise needed for this implementation, as well as the buy-in from the executive needed to be obtained in order for the deployment to be funded and supported.

Furthermore, the Free State government departments also utilise the BI systems to provide the necessary information or services to the community as expected by the e-Government mandated National Treasury and government entity, the State Information Technology Agency (SITA). Nevertheless, integration of the systems is lacking between these departments, contributing to a poor quality and/or slow service delivery, fragmented usage of the systems and delays in providing information to relevant decision makers that produce different reports.

Three provincial departments, namely: FS Treasury, FS Health and FS CoGTA are selected given that these departments are service-oriented. Of these three provincial departments, the FS Treasury department, facilitates the actual and well-organized assets management, liabilities and financial activities of the province as well as compliance with the financial norms and standards of other departments; to promote good governance, transparency and accountability through substantive reflection of financial activities.

On one hand, since 2006, the above-mentioned provincial departments have been using the following IS tools: Basic accounting system (BAS), Personnel and Salary system (PERSAL), Logistical information system (LOGIS), and VULINDLELA systems (VS) as BI tool, for decision-making processes, albeit there is an apparent lack of integration between these tools across the three departments, while the operation of the technological systems is used in isolation, that is, there is no streamlined processing / dissemination of information, data and technical expertise in the focal departments.

Evidently, the lack of integration and a streamlined process of data/information, all the aforementioned BI tools have failed to enhance both users' and organisational performance (and/or productivity) because the same BI tool often produce different reports and data for decision-making in each department. Nevertheless, given the cost of implementing the BI technology across government departments, it is imperative that it is properly implemented across these departments, but the required technical know-how and expertise is deficient in these provincial departments.

2.5 Conclusion

As technology is rapidly changing, information technology within departments advances and increases business needs, therefore the use of the BI tools will assist the government to realise returns on investment when implementation of BI tools is examined carefully and supported by the management.

In the light of the foregoing discussion, firstly, it is imperative to understand the reason for the lack of integration and streamlined BI tools across the provincial departments, which is one of the objectives of this study. Secondly, given BI tools' cost implementation and the considerable efficiency and operational gains of the system (if properly implemented), what are the (un-)observed constraints limiting the effectiveness of the above-mentioned BI tools in our focal provincial departments? Thirdly, how can the departments make adequate use of the existing BI tools to drive service delivery as well as improve overall organisational performance, particularly as a viable tool to monitor infrastructural projects, reduce overrun cost of implemented projects, produce accurate progress report on budgetary expenditure and asset management?

The answers to the posed questions remains an empirical issue, and cannot be taken as a prior judgment based on an intuitive reasoning from an organisational management viewpoint, hence the significance of this present study, which focuses on evaluating the effectiveness of the VS system as a BI tool within the TTF theoretical framework. It also employs a two-pronged approach that involves the use of principal factor component analysis to uncover unobserved factors responsible for the weakness of this BI tool.

CHAPTER 3: RESEARCH METHODOLOGY AND DESIGN

3.1. Introduction

According to Plano Clark (2005), there are two predominant types of research paradigms, namely: (1) quantitative and (2) qualitative paradigms. Quantitative model is based on the measurement of quantity of some phenomena that can be expressed in terms of quantity; this measurement should be objective rather than subjective and statistically valid according to Kothari (2009). The qualitative model is based on gathering, scrutinizing, and interpreting data by observing some phenomena, while the quantitative model dwells on amounts and measurement of things, the qualitative model dwells on a thorough understanding of definitions, concepts, characteristics, metaphors, symbols, and descriptions of things (Berg, 2007).

In line with the overall objective of this research, the main methodology used was the Task-Technology-Fit (TTF) framework development. This was achieved by following a case study of the effectiveness of the existing business intelligence (BI) technology, namely the Vulindlela System (hereafter, VS technology) across the three focal provincial departments (Treasury, Health and CoGTA) in the Free State.

In order to collect data on the case study, the quantitative method involving the use of a survey method to evaluate the perception of users of the VS technology using questionnaires. The choice of the survey method is justified as it is a widely recognised research method to collect data for descriptive purposes (Jackson, 2012:92). It also gives a researcher an insight into behavioural characteristics, such as reasoning ability, experience and knowledge depth of a specific individual or groups. According to Goodhue (1995), users' perception of an information system can either be positive or negative, based on their experience. Therefore, undertaking a survey (questionnaire) was a useful method in achieving the objectives of the study, which is to assess the fit between the tasks performed by the users of the VS technology, and the system capability to meet their task needs on daily basis.

3.2. Survey Design and Research Setting

As an effective organisational diagnostic tool, the TTF is a multidimensional assessment of a decision-making information system, and each dimension must be valid, reliable and consistent (Goodhue, 1998). In general, survey questions are imperfect indicators of its underlying construct (Burn and Grove, 1993). In this study, validity and reliability bias, which are common weaknesses of a survey method is mitigated by randomly using multiple questions which measure the same single construct in the administered questionnaires. This strategy tends to reduce the prevalence of affixing and/or the influence one answer (response) to other questions (Dooley, 2001), and also reinforce the result of reliability tests – Cronbach's alpha – from the PCA model.

The survey questionnaires consist of seventeen (17) questions based on the five-point Likert scale where answers vary from, 1 = ‘strongly disagree’, 2 = ‘disagree’, 3 = ‘neutral’, 4 = ‘agree’, to 5 = ‘strongly agree’. This allows respondents to give their opinion about the functionality and operational capability of the VS technology on the decision-making tasks facilitated and the system ability to enhance their day-to-day performance. The survey questions are designed based on the TTF framework proposed by Goodhue (1995, 1998) to explicitly evaluate the different components of the VS as a focal construct. As proven in the extant literature, the TTF model gives a robust theoretical assessment of an information technology utilised as a decision-making tool within an organisation (Goodhue and Thompson, 1995; Strong et al., 2006, among others) as the model affects a user’s managerial decision-making tasks, performance and productivity, thus adopting the TTF theoretical framework allows us to adequately assess the usefulness of the facilitated tasks, functionality and operational capacity of the VS as a business intelligence technology.

On the research setting, designed questionnaires were administered to VS technology users in three sub-national (provincial) government departments in the Free State Province (hereafter FS) in South Africa, namely the Treasury (FSPT), the FS department of Health (FS DoH) and of Cooperative Governance and Traditional Affairs (FS CoGTA). Strategically, these provincial government departments are situated in the Mangaung Metropolitan area, and tasked with the efficient delivery of essential public services at the provincial and municipal level, to improve the general welfare of the citizen and public governance. At the provincial level, FSPT oversees the allocation of fiscal resources and financial management of the entire province, while the DoH focuses on the provision of quality health care services to citizens at large. The CoGTA deals mainly with economic development and provision of essential public services in the local government and municipal districts.

3.3 Sample Size and Profile of Participants

The selected sample consists mainly of daily users of the VS technology within the human resources, finance and supply chain management units in FSPT, DoH and CoGTA. The job position of respondents shows a well-mixed distribution, which includes senior managers (20%), middle managers (40%), and system controllers (40%) to make up a sample size of ten (10) users. Also, the selection criteria for participants in the survey research based on work experience is somewhat relaxed for comparative analysis purposes. In this way, the researcher could clearly distinguish the perceptions of the new ('millennials') and older group using the VS technology. Based on these selection criteria, selected participants are those with work experience spanning two (2) to five (5) years in using the VS technology, above 18 years of age and willing to participate in the survey research.

3.4. Data Collection

In this study, data collection is carried out utilising both the primary and secondary sources. This study relies on the responses furnished on the administered questionnaires by the participants in the survey as the primary source to collect data. Published articles in reputable national and international journals, text books, unpublished dissertations and online articles were utilised as the secondary sources for data collection.

3.4.1. Collection instrument

The questionnaire is the key data collection instrument in the present study. It comprises of 17 of questions designed to explicitly assess the effectiveness of the VS technology as a business intelligence tool used in three major provincial departments in the Free State. The motivation to use questionnaires as a data collection instrument can be ascribed to following advantages: First, questionnaires can easily be distributed since they require less time to administer. Second, questionnaires typically yield higher response rate (also referred to as completion rate or return rate) since a researcher can distribute and physically collect the completed questionnaires from respondents within a short-time period. Third, a researcher can easily compare the responses of different participants in a survey, to the similar questions to establish a communal or an incongruent perception of participants on a similar question (item). Finally, questionnaires protect the identity of participants, which heightens participation rate, since some (sensitive) details about the participants can be kept hidden or confidential to preserve their privacy.

Admittedly, as stated earlier, questionnaires may be biased as result of inaccurate and unreliable information proffered by respondents (Burn and Grove, 1993). For instance, information from respondents may not reflect their true opinions, but rather they may concede to a researcher's views by answering designed questions to satisfy the researcher. In so doing, valuable information is lost.

Nonetheless, as stated earlier, randomly ordered multiple questions measuring same construct, albeit worded differently are utilised to ensure that reliable and credible information is obtained from respondents. Additionally, the questionnaires designed for our survey research were distributed to participants for completion in the English language, consisting of one section without needing any demographic data (see Appendix I).

3.4.2. Data Collection Procedure

The two sets of data were collected. The survey questionnaires were electronically distributed (via email) to participants for completion, and retrieved by the researcher (see Appendix I). The data were collected over a period of six (6) months. A structured questionnaire (see Appendix I) was designed to capture the main aspects of the study's Vulindlela system. Secondly, follow-up interviews with participants that could not respond to the distributed email were conducted.

3.5. Data Analysis

The collected data was analysed using the following procedure. First, the responses of the participants were collated into an excel spreadsheet, for descriptive and graphical illustration purposes. Second, the data in the excel spreadsheet was imported into a Statistical Package for Social Science (SPSS ver. 25) statistical program to carry out a factor analysis, specifically by employing a Principal Component Analysis (PCA) model, and a battery of diagnostic tests assessing sampling adequacy Kaiser-Meyer-Olkin, (KMO) and internal consistency – reliability (Cronbach's Alpha) of the survey questions, were applied. The linear relationship between the survey questions was established using the Spearman-rho ranked correlation analysis, while the descriptive statistics of the data is evaluated using common statistical measures as means and standard deviation.

Conversely, the survey responses (feedback) are generally narrative (or descriptive) by design, but the conversion of the survey responses to scalar or ordinal index is required for the specification of an empirical model, which is the benefit of factor analysis. The factor analysis approach allows factorability of the 17 TTF items (administered survey questions) evaluating the effectiveness of the VS technology by generating (ordinal) indexes of correlated questions as a measure of the observed construct (i.e. the VS technology). To this end, a principal component analysis (PCA) was employed to reduce measured variables (in this case, the survey responses) to a smaller set of composite components extracted as unobservable common factors, as a measure of the VS technology.

3.5.1. Assessing the Robustness of the Empirical Model.

As mentioned earlier, the prescribed diagnostic tests in the empirical literature were applied to test the validity of the collected data as well as the robustness of the computed PCA model for the extraction of common unobserved factor components that measures the effectiveness of the VS technology construct. To obviate misspecification bias and spurious results which could lead to an unreliable conclusion, the dataset and empirical results were subjected to rigorous analytical assessment, including: (i) descriptive statistics (mean and standard deviation), (ii) correlation analysis (Spearman-rho), (iii) Kaiser-Meyer-Olkin (KMO) test[1] and (iv) Cronbach Alpha test[2].

Firstly, descriptive statistics describe the basic features of data, and also provide simple summaries about samples and measures both the tabular and graphical representations used for quantitative analysis (Privitera, 2012:3). Secondly, it is imperative to evaluate the strength and direction of the linear relationship between variables (Pallant, 2010:128), while the correlation coefficient ascertains the nature of the linear relationship between two variables, whether positive or negative (Vik, 2014:56). Although both the Pearson (r) and Spearman rho (ρ) correlations analysis is commonly used in factor analysis (Hauke and Kossowski, 2011), the latter is more suitable in our empirical application given Spearman rho's ability to evaluate the relationship between two continuous or ordinal variables, whereas Pearson product-moment correlation evaluates the linear relationship (and strength) between two normally distributed / continuous variables. In addition, the Spearman rank-order correlation is a non-parametric correlation that measures the strength and direction of the monotonic relationship between two ranked variables, rather than the linear relationship that Pearson's correlation measures. Lastly, the standard practice in the empirical literature is followed by using the KMO test proposed by

[1] For analytical purposes, the value of the KMO must be close to 0.5 (minimum) to satisfactory factor analysis (Kaiser, 1974). The criteria for KMO values: 0.5 = barely acceptable; 0.7 – 0.8 = acceptable; $\geq$ 0.9 = very good.
[2] The value of the Cronbach Alpha test typically ranges from 0 to 1. For analytical purposes, values: > 0.9 = excellent; > 0.8 = good; > 0.6 = questionable; > 0.5 = poor; 0.5= unacceptable. A value closer to 1 shows an internal consistency among variables/ ordinal indexes.

Kaiser (1974) and Cronbach's Alpha test (Hair et al., 2006) as diagnostic tests to evaluate the sampling adequacy and internal consistency respectively, between each survey questions/responses (converted to ordinal indexes in SPSS) as a reliable and valid measure of the common latent factors related to a specific construct (i.e. the VS technology).

Considering the correlation matrix, it reveals the existence of both positive and negative association reflected as positive/negative correlation coefficients between the survey questions, as expected. In reference to Goodhue (1998), a more reliable correlation should affirm the polarised views of respondents when administered survey questions are evaluated. It is worth noting that, a positive ρ indicate that as one variable increases the other increases, and a negative ρ suggest an inverse relationship. The closer the correlation (ρ) is to 1 or -1, the stronger the scale reliability of the true concept measurement (McClave and Sincich, 2006). Given the large array of positive/negative correlations observed in the presented matrix, it is imperative to focus on correlation results which are statistically significant to deduce meaningful inference. In all cases, these inferred correlations are statistically significant at 5% and 1% levels.

3.6 Conclusion

In general, this chapter outlines the research design, data treatment and the apt methodological approaches to evaluate the effectiveness of the Vulindlela system – the decision-making BI technology widely used in the provincial government departments, with special focus on three service-oriented departments, namely, FSPT, FS Health and FS CoGTA.

To remedy the limitations of the survey technique, a factor analysis technique is employed as a suitable quantitative method to shed more light on the effectiveness of the VS technology. Generally, factor analysis examines the existing inter-correlations between a large numbers of items (or variables), such as questionnaire responses, by reducing items/variables into smaller groups with common underlying features (known as factors) measuring a single construct. Notably, the factor analysis approach is the most suitable quantitative technique to empirically analyse the effectiveness of the VS since the common components or factors that capture the inherent characteristics of the VS technology are largely unobservable. The application of the factor analysis method allows the extraction of unobservable common factors that define the VS technology, reinforcing the chosen TTF theoretical modelling framework.

More importantly, the survey method relies on the information provided by users of the VS technology in three service-oriented departments. Nevertheless, several techniques were used to reduce the error variance of each respondent, particularly those that are based on subjectivity, such as randomly including similar questions measuring the same construct but in different wording/format in the administered questionnaire. In the present study, the anecdotal evidence from the survey is reinforced by assessing the focal BI tool (in this case, the VS technology) within the TTF theoretical framework – a popular and proven evaluation tool in the extant literature.

The present study goes beyond the TTF framework by taking a more robust empirical approach to achieve the outlined research objective. To do this, a principal factor component analysis was employed, and the results of the model were validated using a battery of diagnostic tests. One major advantage of the factor analysis model is that it uncovers the *unobserved* common factor components (in this case, correlated survey questions) measuring the construct – the VS technology.

All in all, the research method approach employed in the study is expected to highlight on the effectiveness of the VS technology, its weakness and possible remedial actions needed to improve the overall performance of the focal provincial departments, the main users and the system performance. The detailed results of the methodological approach are presented and discussed in the next chapter.

CHAPTER 4: DATA ANALYSIS, RESULTS AND DISCUSSION

The data analysis results of both the survey and factor analysis are discussed in this section. The analysis of the results is divided into two sub-sections, the first focusing on responses of the survey participants to the administered questionnaires, and the inferences obtained from the estimated Principal Component Analysis (PCA) model are discussed in the second sub-section.

4.1 Analysis of Respondent's Feedback from the Survey

The modules of the Vulindlela System (VS) are used as a decision-making tool mainly in five service-driven units across the surveyed provincial government departments as shown in Figure 4-1. Comparatively, the largest number of users are found in the two departmental units, namely the supply chain management and human resources units, followed by those in the financial services unit.

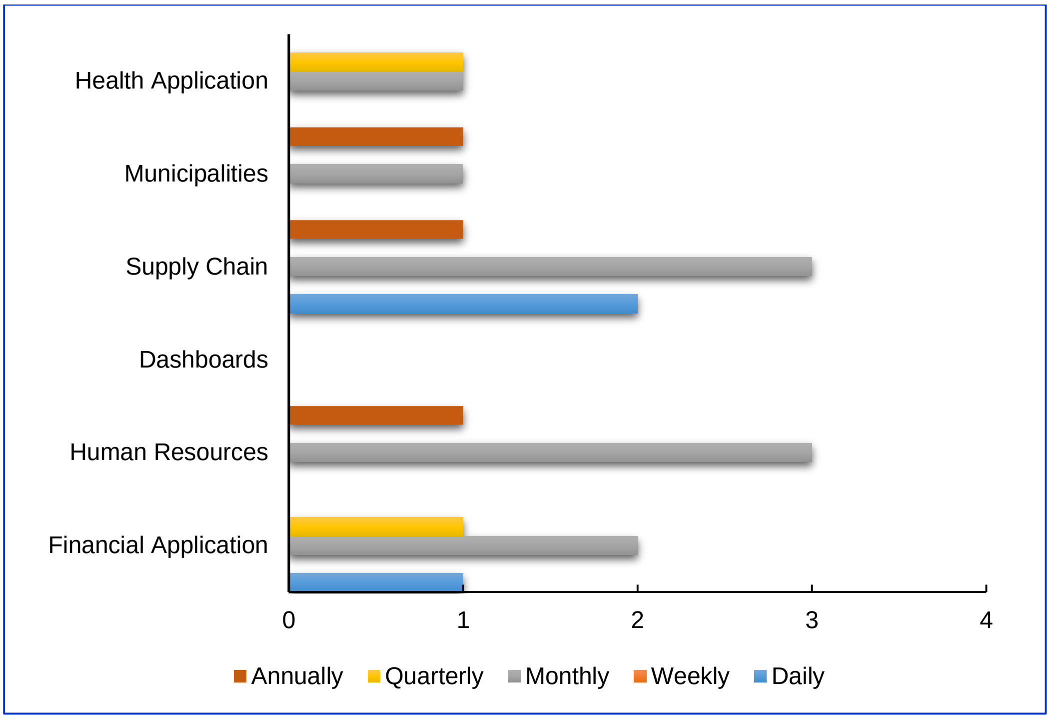

Figure 4-1: Usability frequency of the Vulindlela System
Source: Author

The assessment on the functionality of the VS is presented in Figure 4-2, showing that most of the survey participants (71%), on average considered the VS technology as a user friendly-web-based, easily accessible and flexible system with adequate capability to execute analytical (financial) and decision-making related tasks. On average, 60% of the users perceived the VS as an ineffective intelligent agent, inflexible (difficult to be integrated into other IT system), poor dash-board-based report-generating and decision-making tool. On the other hand, 20% of the users were unsatisfied with the analytical capability and accuracy of the reports generated by the VS. These unsatisfactory sentiments expressed by the users stem from the deficient analytical features to simplify reports generated by the system and the arduous verification process of the generated information/report. In addition, most of these users had insufficient technical know-how on the operational capabilities of the system. On the other hand, some participants (30%) agreed that the VS is an effective decision-making and problem-solving tool useful for facilitating structured and unstructured tasks, on a daily basis, while others (20%) were unsatisfied with the unstructured layout of reports generated by the system and unavailability of relevant content.

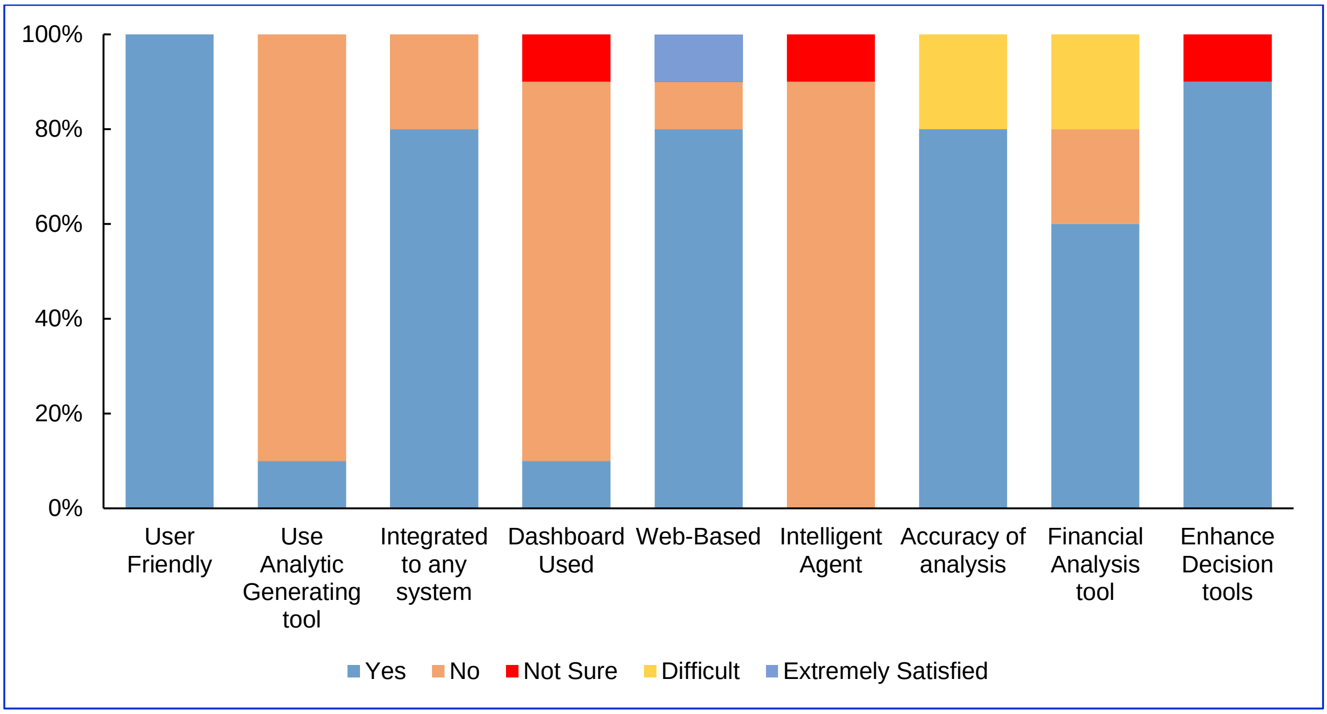

Figure 4-2: IT Functionality of the Vulindlela System
Source: Author

Further, based on the survey participant's feedback, the functionality of the VS is constrained by some technical issues. Given the remoteness of the system and technicians only available at the National departments, VS users (at the provincial departments) are faced with significant turn-around time to resolve technical issues such as password resetting, system errors and software updates, as the system is centrally connected via terminal servers to be accessed by local users. Similarly, the narrow data bandwidth of 5 megabytes and the dependency of the VS on a designated network often limit downloadable contents/information such as large zipped files, thus reducing data accessibility, whereas valuable data/ files can be lost as a result of abrupt interruption in network connectivity.

Furthermore, the reliability and usability of the system can be significantly improved by providing comprehensive technical training to all users of the VS in the focal provincial departments, testing the system in different network environment and continuous development of new software, and upgrade of operating systems (platforms). These changes will not only improve the functionality, security, compatibility (operating with latest web applications) software) and operational capability of the system, but also provide the users with an array of advanced technological features as well as the opportunity to work outside their offices by making use of web-based applications, which in turn, improves daily productivity/performance. Along the same line, by enhancing the functionality of the VS, users would be able to easily access to reports / information within a short-time period, and perform structured, unstructured and non-routine tasks that meet their task profiles.

4.2 Principal Component Analysis (PCA)

To empirically assess the Vulindlela System as a useful BI for decision-making this analysis begins by considering the descriptive statistics of survey questions, in order to identify their individual relative importance and also determine the extent to which these questions account for the characteristic features of the Vulindlela System. For this purpose, we rely on commonly used descriptive statistics such as the mean and standard deviation (σ) values, presented in Table 4-1.

4.2.1 Descriptive Statistics

In general, the majority of the survey questions have a higher mean value greater than ≥ 3 and standard deviation that varies between 0.76 – 1.39, suggesting that these surveyed questions appear to capture accurately the inherent features that uniquely define the Vulindlela System. However, to determine the importance of the survey questions underlying the TTF constructs which defines the Vulindlela System, we impose discriminatory criteria on the observed mean values taking into account only values which are $\geq$ 4. In this context, the usefulness of the Vulindlela System as decision-making BI can be mainly ascribed to seven (7) tasks, which relates to survey questions 9, 11, 16, 17, 5, 8 and 13 shown in Table 4-1. The identified (top) seven tasks that encapsulate the usefulness of the Vulindlela System are as follows. The system: (i) provides accurate information (mean = 4.37 and $\sigma =$ 0.76), (ii) produce quality data (mean = 4.21 and $\sigma =$ 0.79), (iii) timeous data processing (mean = 4.21 and $\sigma =$ 0.92), (iv) produces reports easily (mean = 4.16 and $\sigma =$ 0.69), (v) completion of unstructured tasks (mean = 4 and $\sigma =$ 0.88), (vi) solves non-routine tasks (mean = 4 and $\sigma =$ 1.05), and (vii) improves productivity (mean = 3.95 and $\sigma =$ 1.08).

Table 4-1: Usefulness of the Vulindlela System across three Free State Provincial Government Departments

	Ranked NQ	m	σ
My tasks are dependent on receiving accurate information from other systems	9	4.37	0.76
I would give the information provided by the Vulindlela system a high rating in terms of quality	11	4.21	0.79
The Vulindlela system process processes your tasks timeously	16	4.21	0.92
It is easy to draw reports through Vulindlela system	17	4.16	0.69
Is the Vulindlela system very useful to complete unstructured tasks	5	4.00	0.88
Often solve task problems that are non-routine	8	4.00	1.05
Using the Vulindlela system frequently improves my performance productivity	13	3.95	1.08
Are the functions of the Vulindlela system useful	3	3.89	0.74
Are the Vulindlela system capabilities compatible with my tasks profile	6	3.79	1.08
Using the Vulindlela system improves my decision-making effectiveness	14	3.74	0.87
Is the Vulindlela system error-free	7	3.63	1.30
The Vulindlela system quickly responds to my data requests	10	3.58	1.26
The Vulindlela system can flexibly adjust to meet new demands	12	3.58	1.12
I find Vulindlela system easy to use	15	3.58	1.39
Do you find Vulindlela system very useful to perform unstructured tasks	2	3.42	1.35
the capabilities of the Vulindlela system are compatible with my decision task profile	4	3.21	1.27
Are functions of the Vulindlela system adequate	1	2.58	1.64

Note: NQ – original number of ranked survey question, m *= mean and* σ *= standard deviation*

4.2.2 Communalities

Next, before proceeding with the factor analysis method, communalities among survey questions were evaluated to obviate misspecification bias and unreliable inference. Generally, communalities show how much of the variance in a variable has been accounted for in the extracted factors. Ideally, communality value is expected to be more than 0.5 for each question to be considered suitable for factor analysis[3], otherwise these variables must be removed before undertaking factor analysis. The communalities of each survey question (variable) using the principal component analysis (PCA), and the result are presented in Table 4-1. As can be seen,

[3] Usually communality coefficients give the lower bound estimate of reliability of the scores on a variable (Thompson, 2004:20).

the communality coefficients (h^2) of the variables (survey question) are generally high, ranging from 0.71 to 0.91. This inference validates the inclusion of all the survey questions (modelled as ordinal indexes) in a PCA model. Also, it has been proven that, in factor analysis, h^2 can also be viewed as a R^2 –type effect since these coefficients give the variance of a measured variable reproduced by a set of extracted factors (see, for example, Odum, 2011; Thompson, 2004). In statistical analysis, R^2 typically shows the "goodness-of-fit" of a linear model; the higher a R^2, the better the specified model fits the data. By implication, the observed high h^2 indicates that all the survey questions in Table 4-2 can accurately explain (or measure) a large proportion of the evaluated construct (in this case, the VS) using a principal factor analysis approach.

Table 4-2: Communalities for the 17 Survey Questions and Respondents Feedback (Full Sample)

		Initial solution	Extracted solution
Q1	Are functions of the Vulindlela systems adequate	1	0.74
Q2	Do you find Vulindlela system very useful to perform unstructured tasks	1	0.86
Q3	The functions of the Vulindlela System are useful	1	0.82
Q4	The capabilities of the Vulindlela system are compatible with my tasks profile	1	0.73
Q5	The functions of the Vulindlela system make the performance of my tasks easy	1	0.91
Q6	I will recommend others to use the Vulindlela system to perform their tasks	1	0.72
Q7	Is the Vulindlela system error-free	1	0.89
Q8	I often solve task problems that are non-routine	1	0.76
Q9	My tasks are dependent on receiving accurate information from other systems	1	0.74
Q10	The Vulindlela System quickly responds to my data requests	1	0.79
Q11	I would give the information provided by the Vulindlela system a high rating in terms of quality	1	0.89
Q12	The Vulindlela system can flexibly adjust to meet new demands	1	0.85
Q13	Using the Vulindlela system improves my performance productivity	1	0.84
Q14	Using the Vulindlela system improves my decision-making effectiveness	1	0.84
Q15	I find the Vulindlela system easy to use	1	0.90
Q16	The Vulindlela system processes your tasks timeously	1	0.73
Q17	It is easy to draw reports through the Vulindlela systems	1	0.73

4.2.3 Correlation Analysis

In what follows, the nature of the linear association between the designed survey questions to determine the effectiveness of the VS based on the TTF framework is established using the Spearman rho (ρ) ranked correlation analysis. As discussed earlier, this correlation measure is preferred since it measures the strength and direction of the monotonic relationship between two ranked variables/ordinal indexes rather than the linear relationship that Pearson's correlation measures. The result of the Spearman rho's correlation among the survey questions (full sample) is provided in Table A-1 (in Appendix I), as a matrix.

A closer look at the correlation matrix (Table A-1 in Appendix I) suggests a bi-directional (i.e. a feedback effect) positive correlation between the ability of the Vulindlela system (hereafter, the system) to perform unstructured tasks (Q2) and ability of the users to easily perform tasks using the system(Q5). The same positive feedback correlation exists between the ability of the system to be rated highly for producing quality information (Q11) and its capacity to effectively enhance the decision-making process (Q14), while a unidirectional (one-way) positive correlation exists between: the usage of Vulindlela system to improve productivity/performance (Q13) and the ease of producing reports (Q17). These inferred correlation relationships are statistically significant at 5% and 1% levels. On the contrary, there is also some statistically significant inverse (negative) correlation between the usefulness of the functions in the Vulindlela System (Q3) and recommending the system to others (Q6), and vice-versa. Further analysis also ascertained a one-way negative correlation among the following pairs of criteria gauging the effectiveness of the Vulindlela System, which include: whether the System is error-free (Q7) and its usefulness to execute unstructured tasks (2); the flexibility of the System to execute additional/new–tasks (Q12) and the ease of producing reports (Q17); the flexibility of the System to execute additional/new–tasks (Q12) and the ease of using the Vulindlela system (15); the ease of producing reports using the System (17) and the usage of the Vulindlela system to improve productivity/performance (Q13).

The correlation relationship between the use of the System to perform task easily (Q5) and recommending it to others (Q6) is inconclusive due to the inferred statistically significant unidirectional positive (negative) correlations between these evaluation criteria. In all cases, these observed correlation relationships are statistically significant at either 5% or 1% levels. Overall, the result of the Spearman rho correlation analysis suggests that the strength of the Vulindlela System as a decision-making business intelligence tool can be attributed to its ability to perform unstructured tasks, collate quality information, enhance decision-making and productivity. On the other hand, the weakness of the system can be, partly ascribed to its inflexibility to execute new tasks and relative difficulty in using the System to perform daily tasks.

4.3 Empirical Results: PCA Model 1 (Full Sample)

Having evaluated the factorability of the 17 survey questions, the participants' response to these questions was analysed using the principal components analysis (PCA) since the empirical aim of this study was to identify and compute composite scores for the most important unobservable latent factors underlying the Vulindlela System as a decision-making BI. To that end, a principal factor component analysis with an Oblimin rotation using Kaiser Normalization is applied, and convergence was achieved in 20 iterations. The results of the PCA are reported in Tables 4-4 and 4-5.

The reported results in Table 4-3 indicate the total variance explained by each extracted factors indicating the degree of variability in the data that is accounted for by the extracted latent factors. Specifically, the solution of the PCA shows a total of six (6) latent factors, which cumulatively explained roughly 81% of the variance in the data. These extracted factors are justified by considering, first, the reported large Eigenvalues which exceed unity[4]. Keeping with the Kaiser criterion suggests to retain those factors with eigenvalues equal or higher than 1 (see, Fabrigar et al., 1999). Second, using the scree plot **(**see Figure A-1 in Appendix I**)** which graphs the eigenvalues of each factor against the ordinate component number. Note that the inflexion point– where the factors "tapered off" – on the scree plot shows that, apart from the first six factors, subsequent factors have negligible loadings with corresponding low eigenvalues that are less than unity, confirming the insignificance of these remaining factors.

[4] The Eigenvalue (or latent root) is the column sum of squared loadings and represents the amount of variance accounted for by a factor. Usually, Eigenvalue greater than 1 are considered as significant, whereas, values less than 1 are disregarded.

Table 4-3: Total Variance Explained and Factor Loading of Extracted Latent Factors (Full Sample)

Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
3,52	20,69	20,69	3,52	20,69	20,69	2,79
2,97	17,50	38,18	2,97	17,50	38,18	2,85
2,36	13,91	52,09	2,36	13,91	52,09	2,45
2,14	12,61	64,70	2,14	12,61	64,70	2,47
1,76	10,37	75,08	1,76	10,37	75,08	1,91
1,05	6,17	81,25	1,05	6,17	81,25	2,18
0,89	5,26	86,51				
0,70	4,09	90,61				
0,45	2,66	93,27				
0,39	2,32	95,59				
0,28	1,63	97,22				
0,23	1,33	98,55				
0,15	0,91	99,46				
0,07	0,42	99,88				
0,02	0,12	100,00				
0,00	0,00	100,00				
0,00	0,00	100,00				

In the context of evaluating the effectiveness of the Vulindlela system (in this case, the construct), the first three factors explained about 21%, 18% and 14%, whereas the remaining three factors explained about 13%, 10% and 6% of the variance in the data, respectively. Also, the relative importance of each factor can be assessed using the factor loadings (i.e. weights and correlations between each variable and the factor): The higher the load, the more relevant in defining the factor's dimensionality. On this basis, the second factor appears to be more important than the first, followed by the fourth, third, sixth and the fifth factors. By interpretation, the main features that largely defines the effectiveness of the Vulindlela system as a decision-making BI can be explained by the extracted six latent factors, with varying specificities. However, an in-depth analysis of the extracted latent factors to measure the focal construct (Vulindlela system) is vital to disentangle the contribution of various components underscoring each latent factor.

In what follows, the contents of the survey questions that load onto the same factors are considered to identify common themes. For logical analysis, the extracted six factors are associated with: (i) *productivity (or performance) enhancement* (factor 1), (ii) *system functionality* (factor 2), (iii) *task execution* (factor 3), (iv) *perform non-routine task* (factor 4), (v) *operational capability* (factor 5) and (vi) *decision-making and system flexibility* (factor 6).

The components of these factors derived from the factor analysis are presented in Table 4-5**.** To provide enriching information on the components of the extracted factors, the coefficients of factor loadings less than 0.3 were suppressed. This analytical approach allows inferred results to be tractable, removes clutter of low correlations among variables and also provides an in-depth insight on the relative importance of individual variable (i.e. factor components) to the construct that is being evaluated. Given the empirical aim of this analytical exercise, factor components with positive (negative) coefficients are viewed as the strength (weakness) of the focal construct under study.

Based on the survey questions and respondent feedback, the factor analysis result reveals that, among the components of factor 1 (*performance enhancement*), the capability of the Vulindlela system to improve users' productivity (or performance), and execute structured task are some of the crucial features of the system. On *system functionality* (factor 2), the usefulness of the diverse functions provided by the system emerged as a significant benefit derived from the system; nonetheless, the system compatibility to different task and solving non-routines also matter, to a lesser extent. Another main advantage of the Vulindlela system as a decision-making BI relates to its ability to easily execute tasks, and the perceived error-free feature of the system as reflected by factor 3 (*task execution*). The ability to execute non-routine task is a prominent valuable feature of the system as reflected by factor 4.

Taking into account the *operational capability* of the Vulindlela system (factor 5), the quick responsiveness of the system to data requests and its compatibility with task profile emerged as notable features. Apart from this, the flexibility of the system to perform new tasks as well as being a user-friendly information system are viewed as equally important features of the Vulindlela system as indicated by the sixth latent factor. A closer look at the result in Table 4-4 revealed some common draw-backs of the Vulindlela system among the extracted six factors. These inadequacies include: incapability to perform unstructured and non-routine tasks (factors 2, 3 and 6); inability to meet the demand of new tasks (factors 3 and 5); difficulty in drawing reports (factors 1, 4 and 6).

Table 4-4: Pattern Matrix of Extracted Factor Components (Full Sample).

	Factor 1: Productivity enhancement	Factor 2: System Functionality	Factor 3:Task execution	Factor 4:Peform non-routine task	Factor 5: Operational Capability	Factor 6: Decision-making and system flexibility
Using Vulindlela system improves my performance productivity	0,88					
The Vulindlela system processes my tasks timeously	0,81					
The functions of the Vulindlela System are useful		0,89				
I will recommend others to use the Vulindlela system to perform their tasks		-0,72	0,21	0,35		
My tasks are dependent on receiving accurate information from other systems	-0,55	-0,68				
Are functions of the Vulindlela systems adequate	0,28	-0,53		-0,48		0,23
The functions of the Vulindlela system make the performance of my tasks to be easy		-0,26	0,90			0,24
Is the Vulindlela system error-free		0,27	0,89			
Do you find Vulindlela system very useful to perform unstructured tasks	0,46	-0,42	0,50		0,32	-0,23
I would give the information provided by the Vulindlela system a high rating in terms of quality			-0,26	-0,91		
Using the Vulindlela system improves my decision-making effectiveness			0,30	-0,66		0,49
It is easy to draw reports through Vulindlela system	-0,55			-0,56		-0,22
I often solve task problems that are non-routine	-0,30	0,28	-0,26	0,52	0,44	
The Vulindlela system quickly responds to my data requests		-0,36			0,82	
The capabilities of the Vulindlela system are compatible with my tasks profile		0,29			0,74	0,23
I find the Vulindlela system easy to use					0,41	0,82
The Vulindlela system can flexibly adjust to meet new demands			-0,32		-0,33	0,71

Note: Rotation method = Oblimin with Kaiser Normalization, and rotation converged in 20 iterations. To ensure meaningful analysis, coefficient of factors components lower than 0.3 (in absolute value) were suppressed.

By and large, these empirical findings ascertain effectiveness of the Vulindlela system, in particular results of the factor components corroborate most of the Spearman rho's non-parametric correlation result, with very few inconclusive results, for instance, the ease of extracting report from the system. In particular, our findings align with the theoretical concept of the TTF asserting that use of technology may produce different outcomes, depending upon its configuration and the facilitated task (Goodhue and Thompson, 1995).

Furthermore, it is widely accepted that the Goodhue's TTF theoretical model tend to produce measures that are correlated and distinct, while obtained results accurately predict underlying theoretical concepts. Since this study relied on the TTF model proposed by Goodhue (1995, 1998) to evaluate the effectiveness of the Vulindlela system (i.e. construct), the widely used KMO (Kaiser, 1974) and Cronbach's Alpha (Hair et al., 2006) diagnostic tests are used to assess the sampling adequacy and reliability of the extracted factors. Table 4-5 gives the descriptive statistics and the result of the KMO and Cronbach's alpha reliability test as the identified six latent factors. Some noteworthy deductions from the reported results are as follows: First, the reported mean and standard deviation statistics of the identified factors indicate a relatively low dispersion among variables (i.e. survey questions) accounted for by these factors. Second, the Kaiser-Meyer-Olkin (KMO) values, measuring sampling adequacy ranges from 0.60 (for both *Productivity Enhancement and System functionality*) and the recommended minimum value of 0.5[5] (for *Perform non-routine task, Operational capability and Decision-making and system flexibility*), except factor 3 which falls into the unacceptable category due to a lower KMO value of 0.43. Out of the six factors, only four passed the internal consistency test using the Cronbach Alpha, with coefficients ranging from 0.7 (for both *Productivity enhancement and Decision-making and system flexibility*) to the moderate value of 0.60 (for both *Task execution and Operational capability*). Lastly, the inter-item correlation of the factors extracted are generally low, ranging from 0.39 (factor 1) to the lowest coefficient of -0.19 (factor 4), suggesting a weak positive/negative linear relationship between variables captured by these factors.

Overall, based on these analyses, three distinct unobservable factors account for the effectiveness of Vulindlela system, namely: *Productivity Enhancement* (7 items), *Operational capability* (3 items), *Decision-making and system flexibility* (5 items) due to the moderate internal consistency of these factors. In addition, the result of the sampling adequacy and reliability broadly justify our empirical goal to evaluate the effectiveness of the Vulindlela system using the TTF theoretical model. The result of these statistical measures can be improved significantly using a larger sample size[6].

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[5] See Kaiser (1974).

[6] In the empirical literature, the exact number of variables perceived as a "large sample size", in factor analysis model, varies from a minimum of 100 variables and above (see, e.g, Fabrigar, et al. 1999; Tabachnick and Fidell, 2007).

Table 4-5: Scale Descriptive Statistics, KMO and Cronbach's Alpha Reliability Tests (Full Sample)

	Factor 1: Productivity enhancement	Factor 2: System Functionality	Factor 3: Task execution	Factor 4: Perform non-routine task	Factor 5: Operational Capability	Factor 6: Decision-making and system flexibility
Mean	13.47	14.18	18.29	7.82	17.29	19.53
Standard deviation	3.46	2.48	3.60	1.47	3.84	4.13
KMO	0.60	0.60	0.43	0.50	0.54	0.50
Cronbach Alpha	0.71	0.27	0.64	-0.50	0.60	0.65
Inter-item correlation	0.39	0.10	0.26	-0.19	0.22	0.23

4.4 PCA Model 2: Evaluating the Vulindlela System using constructed TTF instruments.

Goodhue and Thompson (1995) proved that the TTF theoretical model is a ‘‘technology-to-performance chain’’ model, in which technology utilisation relies on the fit between the technology and the tasks that support it. Also, a perceived good-fit TTF model is expected to identify the link between the perceived capabilities of an information system, facilitated task and the user's competence (Macolin et al. 2000). Thus, to gain an in-depth insight on the effectiveness of the Vulindlela system, survey questions and respondent's feedback with similar characteristics were grouped together into a 12-item TTF instruments – alternative measures to evaluate the Vulindlela system as a BI technology, as presented in Table 4-6 with descriptive statistics.

The descriptive statistics in Table 4-6 reveals that, out of the 12-item TTF instruments (or constructs), the top three features of the Vulindlela system are Currency (CU), Accessibility (AC) and Ease of Use (EU) considering their sizeable mean values of 14.3, 8.33, and 6 respectively. In contrast, the low standard deviation value of CU suggests a lesser dispersion of its TTF instruments from the mean, but the higher values (>7) for both AC and EU indicate a relatively wide dispersion. Next, the sampling adequacy and internal consistency of these constructs were (jointly) examined using the KMO and Cronbach Alpha test. The values of 0.5 and 0.89 were obtained for the KMO and Cronbach Alpha diagnostic tests respectively, confirming the reliability (internal consistency) and ability of the 12 TTF instruments[7] adequately.

[7] Note that, the technical terms “instruments” and “constructs” are used interchangeably for the aggregated 12-TTF items.

Table 4-6: Summary of Measurement Scales and Descriptive Statistics of the 12-TTF item Constructs/Instruments

Construct		Measure	Mean	SD
Currency (CU)			14.33	2.08
	CU1	The capabilities of the Vulindlela system are compatible with my tasks profile		
	CU2	The Vulindlela system can flexibly adjust to meet new demands		
	CU3	Using Vulindlela system improves my performance productivity		
	CU4	I find the Vulindlela system easy to use		
	CU5	The Vulindlela system processes my tasks timeously		
Accessibility (AC)			8.33	7.23
	AC1	My tasks are dependent on receiving accurate information from other systems		
	AC2	The Vulindlela system quickly responds to my data requests		
	AC3	The Vulindlela system can flexibly adjust to meet new demands		
	AC4	Using the Vulindlela system improves my performance productivity		
Ease of Use (EU)			6.00	7.21
	EU1	The functions of the Vulindlela system are useful		
	EU2	The capabilities of the Vulindlela system are compatible with my tasks profile		
	EU3	The functions of Vulindlela system make the performance of my tasks easy		
	EU4	Using the Vulindlela system improves my decision-making effectiveness		
Assistance (AS)			4.60	8.08
	AS1	The Vulindlela system quickly responds to my data requests?		
	AS2	Using the Vulindlela system improves my decision-making effectiveness		
Presentation (PR)			4.33	7.51
	PR1	Do you find the Vulindlela system very useful to perform unstructured tasks		
	PR2	Using the Vulindlela system improves my performance productivity		
	PR3	It is easy to draw reports through the Vulindlela system?		
System Reliability (SR)			3.33	5.77
	SR1	Is the Vulindlela system error-free		
	SR2	The Vulindlela system quickly responds to my data requests		
Meaning (ME)			3.33	5.77
	ME1	The functions of the Vulindlela system are useful		
	ME2	The Vulindlela system quickly responds to my data requests		
Confusion (CO)			2.67	4.62
	CO1	I often solve task problems that are non-routine?		
	CO2	I would give the information provided by the Vulindlela system is high rating in terms of quality		
	CO3	Using the Vulindlela system improves my decision-making effectiveness?		
Level of Detail (LD)			2.67	4.61
	LD1	The functions of the Vulindlela system are useful		
	LD2	I often solve task problems that are non-routine		
Accuracy (AU)			1.67	2.89
	AU1	The functions of Vulindlela system make the performance of my tasks easy		
	AU2	Is the Vulindlela system error-free		
	AU3	My tasks are dependent on receiving accurate information from other systems		
Locatability (LC)			1.67	2.88
	LC1	Do you find the Vulindlela system very useful to perform unstructured tasks		
	LC2	The functions of the Vulindlela system make the performance of my tasks to be easy		
Data Quality (DQ)			0.33	0.58
	DQ1	Are functions of the Vulindlela systems adequate		
	DQ2	I would give the information provided by the Vulindlela system a high rating in terms of quality		
	DQ3	Using the Vulindlela system improves my performance productivity		

Having established the factorability of the constructed twelve-item TTF constructs; the association among these instruments was assessed using the Spearman rho ranked correlation analysis, and the result is reported in Table A-2 (in Appendix I). As anticipated, both positive and negative relationships exist between the constructed constructs in the correlation matrix presented in Table A-2, ascertaining the differentiated link between the Vulindlela system (BI technology), its operational functionality and capacity to execute the required (or new) tasks, from the user's viewpoint.

4.4.1 Empirical Analysis on the 12-TTF item Construct

As discussed earlier, the satisfactory KMO and Cronbach Alpha values testing the sampling adequacy and internal consistency support the estimation of a PCA model using the constructed 12-TTF constructs. Figure A-3 (in Appendix I) gives a graphical representation of the space rotation of the 12-TTF constructs, using the Oblimin rotation method with Kaiser Normalisation using a principal component analysis. The empirical results of the principal component analysis are reported in Tables 4-8, 4-9 and A-1. As can be seen (see Table 4-8), only two latent unobservable factors can be extracted from the 12-TTF instruments, with the first factor explaining a sizeable variance (about 85%) of the system, compared to a lower variance (15%) explained by the second factor. As discuss in the previous section, the large eigenvalues (> 1) and factor loadings provides concrete support for the extracted two factors, as graphically illustrated in the scree plot (see Figure A-2 in Appendix I).

Table 4-7: Total Factor Explained – PCA model for 12-TTF Construct

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	10,21	85,09	85,09	10,21	85,09	85,09	10,21
2	1,79	14,91	100,00	1,79	14,91	100,00	1,87
3	0,00	0,00	100,00				
4	0,00	0,00	100,00				
5	0,00	0,00	100,00				
6	0,00	0,00	100,00				
7	0,00	0,00	100,00				
8	0,00	0,00	100,00				
9	0,00	0,00	100,00				
10	0,00	0,00	100,00				
11	0,00	0,00	100,00				
12	0,00	0,00	100,00				

Next, the internal consistency, sampling adequacy of the two extracted factors is examined using the KMO and Cronbach Alpha tests. The high values of these diagnostic tests and descriptive statistics are provided in Table 4-9. The results of the KMO (Factor 1 = 0.5 and Factor 2 = 0.5) and Cronbach Alpha (Factor 1 = 0.87 and Factor 2 = 0.85) confirm the identified unobserved factors adequately accounting for the perceived TTF model (i.e. the Vulindlela system) using the observable 12-TTF instruments. The inter-item correlation between the components (i.e. grouped instruments) of each factors are 0.48 and 0.74 for factor 1 and 2 respectively, whereas a wide (lesser) dispersion between variance of components of factor 1 (factor 2) from the mean of the data is noticeable, in contrast, it has a lower mean value (4.43) than the second factor (14.5) with only two TTF instruments. The space rotation for the two factors is depicted in Figure A-4 (in Appendix I). Overall, these analyses affirm that these factors are reliable as a consistent measure of the Vulindlela system.

Table 4-8: Scale Description Statistics, KMO and Cronbach's Alpha Reliability Tests

	Factor 1	Factor 2
Mean	4.43	14.50
Standard deviation	34.86	11.09
KMO	0.50	0.50
Cronbach Alpha	0.87	0.85
Inter-item correlation	0.48	0.74
Sample size (N)	10	2

Lastly, to understand the underlying configuration of the TTF constructs of the two extracted latent factors, the pattern matrix generated using the PCA model is examined. Table A-2 provides the pattern matrix for the identified factors, and each factor is termed based on the common theme that characterised the loaded constructs. In line with total variance explained by each latent factors analysed earlier (see Table A-1), a total of 10-TTF constructs were loaded on the first factor, and the second factor comprise two TTF constructs. Factor loadings of the TTF constructs associated with the two latent factors are relatively large (in absolute value), except the *Accessibility* construct with a lower value of 0.39. On the other hand, in the context of evaluating the usefulness of Vulindlela system using the extracted unobservable factors, the inherent characteristics of first latent factor can be ascribed to *System operational capacity* (factor 1), while the second factor is linked to *System functionality* (factor 2).

Conclusively, based on the reported results in Table A-2, all the TTF-item constructs have a notable direct influence on both the *operational capacity* and *functionality* of the Vulindlela system as business intelligence technology, except the *Currency* construct, which confirms some noteworthy shortcomings of the system due to, for example, incompatibility of the system to user's task profile (CU1) and its inflexibility to execute new tasks demanded (CU2), in keeping with prior empirical results inferred in the principal component analysis carried out on the seventeen (17) survey questions.

On the whole, the anecdotal evidence from the survey suggested that the VS is an ineffective business intelligence tool because the benefit derived by the users of the current Vulindlela System, to enhance their performance/productivity, reduce completion time spent on structured/unstructured tasks and the decision-making process, are mostly negligible relative to the poor operational capability of the system. In reference to the Goodhue's (1995, 1998) TTF theoretical framework, it is important that the VS technology satisfy the needs of the users and improve their daily performance, implying that the improvement of the existing VS is heavily dependent on a comprehensive consultation with local users.

Table 4-9: Pattern Matrix of Extracted Latent Factors using PCA.

TTF Constructs	Factor 1: System Operational capacity	Factor 2: System Functionality
System Reliability	1,00	
Meaning	1,00	
Level of Detail	1,00	
Data Quality	1,00	
Assistance	1,00	
Presentation	1,00	
Locatability	1,00	
Accuracy	1,00	
Confusion	1,00	
Currency	-0,96	
Ease of Use		0,98
Accessibility	0,39	0,89

4.5 Framework Development

Based on the results presented in the sections above, the following structural framework is deduced. The framework takes the general structure of Goodhue's (1995, 1998) TTF theoretical framework and borrows concepts from D'Ambra et al. (2013).

The Framework is based the correlation analysis that revealed a statistically significant and positive bi-directional (two-way or feedback effect) association among the following set of TTF constructs: (i) ME, LO, SR, AS and LD, and (ii) DQ, CO, PR and AU, while a positive unidirectional (i.e. one-way) correlation only exists between the LD and PR constructs. In all cases, the positive correlations are statistically significant at 5% or 10% level. On the basis of this inference, a considerable improvement in the data quality, locatability, system reliability and accessibility will not only affect the functionality of the Vulindlela system, but also enhance users' productivity and the overall performance of the organisation using the system. Equally important, the quality of report, data presentation and information gathered using the system has a significant influence on the usage of the system and its future roll-out to other provincial departments.

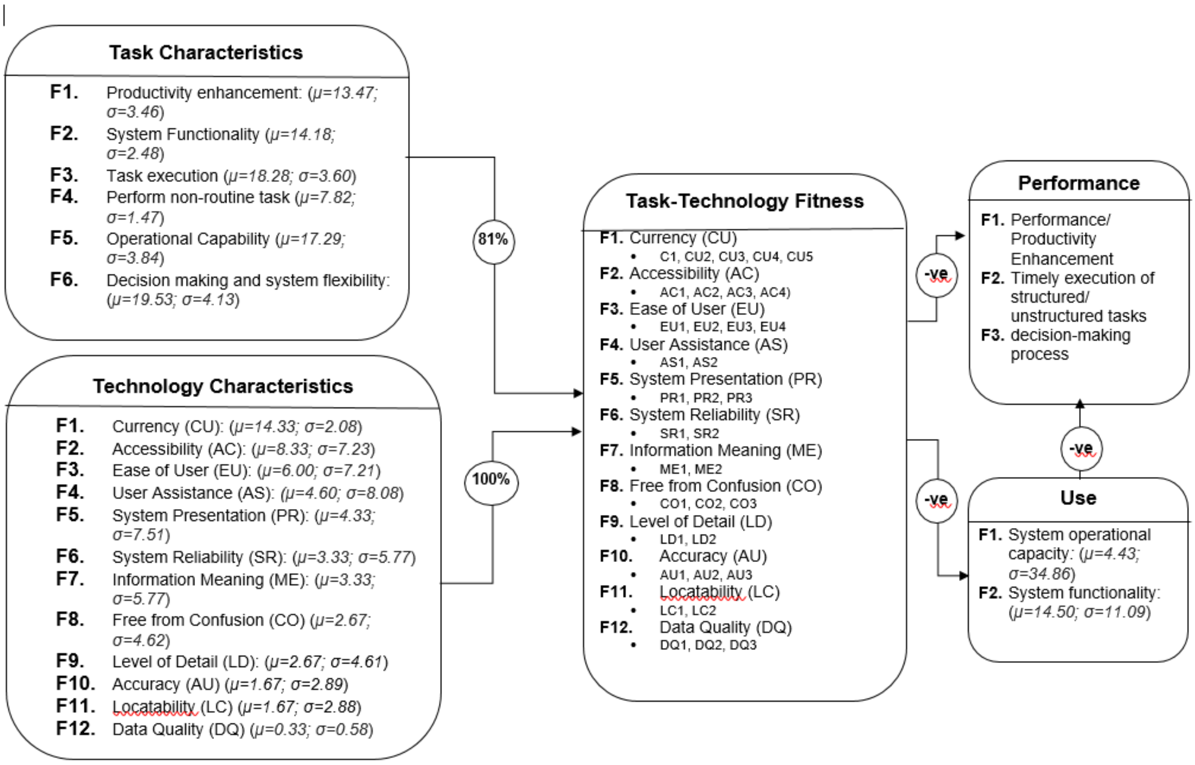

Figure 4-3: The structural framework for the assessment of the Vulindlela System as a BI Tool
Source: Author

The empirical aim of this study is to examine the effectiveness VS technology – a commonly used BI tool in three provincial departments (Treasury, Health and CoGTA) in the Free State. To this end, a survey and empirical techniques were employed within the TTF theoretical framework. To obviate spurious inferences, reduce error variance and subjectivity of the respondents' feedback, random questions measuring the same construct were included in the administered survey questions, while the Spearman rho correlation analysis, KMO and Cronbach Alpha tests was used to validate the internal consistency and sampling adequacy of the 17-item questionnaire designed based on a Likert scale approach. The results of the survey show that most of the users (70%) of the VS technology perceived the system, *inter alia*, as a: user friendly-web based IT system, an easily accessible, problem-solving and flexible BI tool capable of executing analytical (financial) and decision-making related tasks. Also, there is a consensus among some users (30%) that the VS is an effective decision-making and problem-solving tool useful for facilitating (un)structured tasks. In contrast, the majority of the users (60%) considered the VS as an ineffective intelligent BI tool, inflexible (difficult to be integrated into other IT system) with poor dash-board-based report-generating abilities while others (about 20%) were generally unsatisfied with the analytical capability and accuracy of the reports generated by the VS technology. Likewise, deficiency in the technical-know-how and considerable delay in technical support to resolve network issues amplified the ineffectiveness of the VS from the main users' perspective.

On the empirical techniques, two principal component analysis models were constructed to empirically identify the latent (unobserved) components underpinning the weaknesses and strengths of the VS technology, in the context of the TTF framework. While one factor analysis model considered the characteristics of the designed 17 questions as an individual measure of the main construct (i.e. the VS); the second factor analysis model followed the Goodhue (1995,1998) theoretical framework, as 12-TTF items consisting of grouped questions measuring similar features of the VS. Apart from shedding more light on the effectiveness of the VS, the factor analysis results generally reinforced the deduced anecdotal evidence of the survey.

4.6 Conclusion

The spearman rho correlation analysis suggested that the strength of VS as a decision-making business intelligence tool can be associated with the system's ability to perform unstructured tasks, collate quality information, enhance decision-making and productivity, whereas the operational capacity and functionality of the system is limited, in part due to VS inflexibility to execute new tasks and relative difficulty in using the System to perform daily tasks. Secondly, six latent factors with sizeable factor loading (positive and negative signs) were extracted in the 17-item PCA model, suggesting that productivity enhancement, system functionality, task execution, non-routine task performance, operational capability as well as decision-making and system flexibility features were the key determining factors of the implemented VS technology. Major inadequacies of the system identified by latent factors included: incapability of the system to perform unstructured and non-routine tasks (factors 2, 3 and 6); inability to meet the demand of new tasks (factors 3 and 5) and difficulty in generating reports (factors 1, 4 and 6).

Finally, only two latent factors were extracted from the 12-TTF item PCA model, mostly associated with the system's operational capacity (factor 1) and functionality (factor 2). Other results showed that all the 12 TTF-items had a considerable (in)-direct influence on the operational capacity and functionality of the VS as a BI tool, except the Currency construct which accentuated the shortcomings of the VS associated with system incompatibility to meet users' task profiles and inflexibility to execute new task demands, keeping with empirical findings inferred in the 17-item PCA model.

Chapter 5: CONCLUSION AND FURTHER WORK

The preceding chapter focused mainly on the mixed methodological approaches employed in this study to assess the effectiveness of the VS as a widely used BI tool in three service-oriented provincial departments in the Free State (i.e. Treasury, Health and CoGTA), which was the main objective of the present study, and also discuss inferred evidence / results. This final chapter concludes the study by providing a synoptic overview of the study, rationale for the undertaken research work, contributions to extant studies, main findings and policy implications. First, the chapter begins with the study background, followed by the discussion on the rationale for the dissertation. Second, the contribution of the survey and empirical work in the study to existing literature is discussed. Third, a summary of key findings and their policy implications is provided. Fourth, the chapter highlights some limitations of the study. Finally, areas for future research is considered.

5.1. Overview

The National Treasury has invested in BI technologies to the implementation of these BI technologies at the national and sub- national level to ensure the delivery of quality services to the citizens (public) using sophisticated information systems, albeit the universal implementation of BI technologies has been extremely slow, and its applications remains fragmented. Over the years, the National Treasury has striven to extend the usage of BI technologies by implementing these technologies in phases as a piloted programme solely to help government departments, for instance, to facilitate complex public administration tasks, provide fast and quality services, enhance decision-making processes, and gather and analyse technical data.

More recently, the use of BI technologies in the public sector, to optimise efficiency gain, enhance productivity and deliver quality services to the citizen, is gradually becoming popular. Nonetheless, in comparison to government departments elsewhere, in particular, those in the Gauteng province similar public services to the same shareholders, the Free State Government Departments tend to operate their enterprise software and systems in isolation. This lack of integration of Information systems within Free State (FS) government departments' decision processing lengthy and time-consuming, thereby measuring the effectiveness of Business Intelligence (BI) technologies within Free State government departments.

5.2. Rationale for Research

Since the delivery of fast and quality services is one of the top priorities (if not the main) of the national government, it is imperative to evaluate the usefulness of existing BI technologies across the aforementioned service oriented provincial departments, focusing on integral components, for example, operational capacity and IT functionality of the system, as well as, shed some light on the experience of the users of the system. Typically, deduced inferences from this type of assessment of the BI system would not only be beneficial to FS government among other provinces where the implementation of the BI is at a nascent phase, but also enhance service delivery and optimal productivity of users, which is the main aim of this study.

Against this backdrop, this study was intended to examine the effectiveness VS technology – a commonly used BI tool in three provincial departments in the Free State. To that end, a survey and empirical method is employed utilising the TTF theoretical framework, with the latter technique based on a factor analysis technique. The multi-pronged methodological approach used is justifiable on two grounds: First, the factor analysis allows us to identify common unobserved factors, measuring the effectiveness of the VS (as the main construct). Second, the factor analysis validated the anecdotal evidence of the survey, in order to draw a conclusive inference on the strength and weakness of the IT system being studied. Third, the mixed method approach employed in the study is expected to shed more light on the effectiveness of the VS technology, its weakness and possible remedial actions needed to improve the overall performance of the focal provincial departments, the main users and the system performance.

On the empirical technique employed, two principal component analysis models were constructed to empirically identify the latent (unobserved) components underpinning the weaknesses and strengths of the VS technology, in the context of the TTF framework. While, one factor analysis model considered the characteristics of the designed 17 questions as an individual measure of the main construct (i.e. the VS), the second factor analysis model followed the Goodhue (1995,1998) theoretical framework, as a 12-TTF items consisting of grouped questions measuring similar features of the VS. Apart from shedding more light on the effectiveness of the VS, the factor analysis results generally reinforced the deduced anecdotal evidence of the survey. In the survey, spurious inferences, reduced error variance and subjectivity of the respondent’s feedback was obviated by including random questions measuring the same construct in the administered survey questions. The well-known Spearman rho correlation analysis, KMO and Cronbach Alpha tests were employed to validate the internal consistency and sampling adequacy of the 17-item questionnaire designed based on a Likert scale approach.

5.3. Contribution of study

This present study contributes to the existing literature in terms of assessing the strength and weakness of business intelligence (BI) technology. To the authors' knowledge, this is the first attempt to assess the effectiveness of an information technology used across government departments – a major provider of public services. In achieving this, the three objectives set out in the beginning of the study were all achieved. Objective 2 – application of TTF to derive and a generic assessment framework for VS - was the emphical objective of this research. This has been successfully achieved through the quantitative (principal component analysis) analytical techniques to highlight the usefulness and perceived shortcomings of VS as a BI technology utilising the Goodhue's TTF theoretical model. This multi-pronged factor analysis method employed not only provides a robust empirical assessment but also reinforces the anecdotal findings of the case study selected. The resulting structural Framework is presented 4.5 of this disseration.

5.4. Key Findings and Policy Recommendation

The results of the survey show that most of the users (70%) of the VS technology perceived the system, inter alia, as a: user-friendly-web-based IT system, an easily accessible, problem-solving and flexible BI tool capable of executing analytical (financial) and decision-making related tasks. Also, there is a consensus among some users (30%)that the VS is an effective decision-making and problem-solving tool useful for facilitating (un)structured tasks. In contrast, the majority of the users (60%) considered the VS as an ineffective intelligent BI tool, inflexible (difficult to be integrated into other IT system) tool with poor dash-board-based report-generating ability, while others (about 20%) were generally unsatisfied with the analytical capability and accuracy of the reports generated by the VS technology. Conversely, deficiency in the technical-know-how and considerable delay in technical support to resolve network issues amplified the ineffectiveness of the VS from the main users' perspective.

The inferences from the empirical analysis show that: firstly, the spearman rho correlation analysis suggest that the strength of VS as a decision-making business intelligence tool can be associated with the system's ability to perform unstructured tasks, collate quality information, enhance decision-making and productivity, whereas, the operational capacity and functionality of the system are limited, in part, due to VS inflexibility to execute new tasks and relative difficulty in using the System to perform daily tasks. Secondly, six latent factors with sizeable factor-loading (positive and negative signs) were extracted in the 17-item PCA model, suggesting that productivity enhancement, system functionality, task execution, non-routine task performance, operational capability as well as decision-making and system flexibility features are the key determining factors of the implemented VS technology.

Major inadequacies of the system identified by latent factors include: incapability of the system to perform unstructured and non-routine tasks (factors 2, 3 and 6); inability to meet the demand of new tasks (factors 3 and 5), and difficulty in generating reports (factors 1, 4 and 6). Finally, only two latent factors were extracted from in the 12-TTF item PCA model, mostly associated with the system's operational capacity (factor 1) and functionality (factor 2).

Other results showed that all the 12 TTF-items have a considerable (in) direct influence on the operational capacity and functionality of the VS as a BI tool, except the Currency construct which accentuates the shortcomings of the VS associated with system incompatibility to meet users' task profile and inflexibility to execute new tasks demanded, in keeping with empirical findings inferred in the 17-item PCA model.

Based on the findings of this study, the efficiency gain derived by the main users in the focal provincial departments is relatively low vis-à-vis the high cost of implementing the system, and also at odds with Goodhue's TTF framework.

For policy design, some remedial actions to improve the effectiveness of the VS as a BI tool entails the following: Foremost, the reliability and usability of the system can be significantly improved by providing comprehensive technical training to all users of the VS in the focal provincial departments, testing the system in different network environment and continuous development of new software, upgrade of operating systems (platforms). These changes will not only improve the functionality, security, compatibility (operating with latest web applications) software) and operational capability of the system but also provide the users with an array of advanced technological features as well as the opportunity to work outside their offices by making use of web-based applications, which in turn, improves daily productivity/performance. Secondly, the functionality features of the existing VS technology needs to be upgraded to allow, for instance, easy accessibility of reports / information with short turn-around time, performance of (un) structured and non-routine tasks that meet the users' task profiles. Taken together, these remedial actions would increase total productivity (overall performance) of both the users and the departments studied.

5.5. Limitations of study

Although this study highlighted the effectiveness of the Vulindlela system (hereafter, VS) – decision-making BI technology widely used in the public sector (provincial government departments), albeit it suffers from two limitations. First, the perceived TTF constructs utilised as an evaluation tool to measure the VS depends mostly on respondents' feedback on the administered survey. As a result, the credibility and reliability of the information provided cannot be established. Arguably, biased is introduced on any research methodology that is reliant on volunteers depending on their ability and willingness to volunteer (Lin and Huang, 2008). Second, despite significant inferences produced by the two-pronged analysis by making use of a small sample, the robustness of the inferred results and statistical power of the model will significantly improve by using a larger sample size.

5.6. Areas for Future research

This study has opened several lines of inquiry for other researchers and policy makers to consider. Firstly, in addition to the Vulindela System, it would be beneficial to expand the scope of this present study by examining the effectiveness of other BI tools mentioned in Chapter 2 (i.e. LOGIS, PERSAL and BAS) with the application of a mixed-methodology as well as within the TTF theoretical model. This type of research program is likely to unearth the impeding factors causing lack of integration of these BI tools across the different provincial departments.

Second, the survey and empirical evaluation of the Vulindela System needs to be extended to other service-oriented or non-service-oriented provincial departments in the Free State to provide a holistic view of the use of VS and unrelated challenges faced by other main users elsewhere. A major advantage of a typical research programmes entails the access to large number of users, diverse users' perceptions on the IT system and sufficient data, providing rich information for credible survey and a robust empirical analysis. Further study to address is the evolution of BI and its impact on decision-making in government departments is recommended.

Finally, the scope of the present research can also be extended to other provinces across South Africa as well as national government departments in order to enhance integration of IT systems functioning as BI tools and synergy between users and technical support, and to provide access to large-scale information to facilitate tasks easily, analyse complex data, disseminate data accurately, improve service delivery and ensure the adoption of effective policy.

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Technical Appendix.

- *Correlation measures: Pearson versus Spearman rho correlations.*

To evaluate the strength and direction of the linear relationship between variables whether it is positive or negative, the two commonly used correlation coefficient are the Pearson (r) and Spearman rho (ρ) correlations analysis are commonly used in factor analysis. The mathematically represntatio of these correlation measure, are as follows:

$$\text{Pearson correlation, } r = \frac{N\sum xy.\sum(x)(y)}{\sqrt{N\sum x^2 - \sum(x^2)][N\sum y^2 - \sum(y^2)]}} \qquad (1)$$

where, N is the number of observation; $\sum xy$ denotes sum of product of paired scores ; $\sum x$ and $\sum y$ are the sum of x and y scores respectively; $\sum y^2$ and $\sum x^2$ represent the sum squared of x and y scores respectively.

$$\text{Spearman rho ranked correlation, } \rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \qquad (2)$$

where, d_i represent the difference between ranks of corresponding variables, and n is the number of observation. In the case, where ranks are tied, then, $\rho = \frac{\sum_i (x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum_i (x_i - \overline{x})^2 (y_i - \overline{y})^2}}$ with i denoting paired scores.

Appendix I: Tables and Graphs

Table A-1: Spearman Rho Non-parametric Correlation Matrix for 17 Survey Questions and Respondents' feedback (Full Sample)

	QI	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	15	16	17
Q1 *(cor. coef.)*	1,00	0,40	-0,30	0,16	0,24	0,09	-0,07	-0.57*	0,20	0,18	0,36	0,32	0,42	0,45	0,48	0,36	0,01
Sig.level		0,11	0,24	0,53	0,35	0,74	0,80	0,02	0,45	0,50	0,15	0,22	0,09	0,07	0,05	0,16	0,98
Q2 *(cor. coef.)*	0,40	1,00	-0,48	0,13	0.59*	0,36	0,28	-0,14	-0,02	0,30	-0,09	-0,23	0,21	0,09	0,09	0,31	-0,34
Sig.level	0,11		0,05	0,63	0,01	0,15	0,28	0,59	0,94	0,24	0,72	0,37	0,42	0,74	0,72	0,23	0,18
Q3 *(cor. coef.)*	-0,30	-0,48	1,00	0,22	-0,40	-0.67**	0,16	0,27	-0,38	-0,32	0,20	-0,01	-0,17	0,08	0,05	0,03	0,25
Sig.level.	0,24	0,05		0,39	0,11	0,00	0,54	0,29	0,13	0,22	0,43	0,96	0,51	0,77	0,86	0,91	0,34
Q4 *(cor. coef.)*	0,16	0,13	0,22	1,00	-0,09	-0,01	0,03	0,16	-0,25	0,38	0,21	-0,01	0,21	0,11	0.54*	-0,03	-0,01
Sig.level.	0,53	0,63	0,39		0,73	0,95	0,90	0,54	0,34	0,13	0,43	0,96	0,42	0,67	0,02	0,92	0,98
Q5 *(cor. coef.)*	0,24	0.59*	-0,40	-0,09	1,00	0.51*	0,48	-0,17	0,21	0,06	-0,18	0,00	0,12	0,32	0,09	0,07	-0,08
Sig.level	0,35	0,01	0,11	0,73		0,03	0,05	0,52	0,43	0,81	0,48	1,00	0,66	0,21	0,74	0,79	0,77
Q6 *(cor. coef.)*	0,09	0,36	-0.67**	-0,01	0.51*	1,00	0,06	-0,04	0,27	0,04	-0,46	-0,03	-0,02	-0,11	0,00	-0,35	-0,16
Sig.level	0,74	0,15	0,00	0,95	0,03		0,81	0,87	0,29	0,88	0,06	0,92	0,95	0,69	0,99	0,17	0,54
Q7 *(cor. coef.)*	-0,07	0,28	0,16	0,03	0,48	0,06	1,00	-0,20	-0,37	-0,05	-0,16	-0.52*	0,14	0,02	-0,18	0,31	0,31
Sig.level	0,80	0,28	0,54	0,90	0,05	0,81		0,44	0,14	0,84	0,55	0,03	0,60	0,93	0,49	0,22	0,23
Q8 *(cor. coef.)*	0.51*	-0,14	0,27	0,16	-0,17	-0,04	-0,20	1,00	0,00	0,10	-0,44	-0,16	-0,44	-0,29	0,00	-0,26	-0,13
Sig.level.	0,02	0,59	0,29	0,54	0,52	0,87	0,44		0,99	0,72	0,08	0,53	0,08	0,25	0,99	0,31	0,62
Q9 *(cor. coef.)*	0,20	-0,02	-0,38	-0,25	0,21	0,27	-0,37	0,00	1,00	0,16	-0,20	0,17	-0,32	-0,10	0,09	-0,46	0,14
Sig.level.	0,45	0,94	0,13	0,34	0,43	0,29	0,14	0,99		0,54	0,45	0,51	0,22	0,69	0,74	0,07	0,60
Q10 *(cor. coef.)*	0,18	0,30	-0,32	0,38	0,06	0,04	-0,05	0,10	0,16	1,00	0,07	-0,09	0,00	-0,04	0,27	-0,09	-0,12
Sig.level	0,50	0,24	0,22	0,13	0,81	0,88	0,84	0,72	0,54		0,78	0,72	0,99	0,87	0,29	0,73	0,64
Q11 *(cor. coef.)*	0,36	-0,09	0,20	0,21	-0,18	-0,46	-0,16	-0,44	-0,20	0,07	1,00	0,20	0,00	0.65**	0,04	0,23	0,28
Sig.level	0,15	0,72	0,43	0,43	0,48	0,06	0,55	0,08	0,45	0,78		0,44	0,99	0,00	0,88	0,38	0,28
Q12 *(cor. coef.)*	0,32	-0,23	-0,01	-0,01	0,00	-0,03	-0.52*	-0,16	0,17	-0,09	0,20	1,00	0,32	0,34	0.49*	-0,01	-0,40
Sig.level.	0,22	0,37	0,96	0,96	1,00	0,92	0,03	0,53	0,51	0,72	0,44		0,21	0,18	0,05	0,96	0,11
Q13 *(cor. coef.)*	0,42	0,21	-0,17	0,21	0,12	-0,02	0,14	-0,44	-0,32	0,00	0,00	0,32	1,00	-0,03	0,27	0,45	-0.48*
Sig.level	0,09	0,42	0,51	0,42	0,66	0,95	0,60	0,08	0,22	0,99	0,99	0,21		0,90	0,29	0,07	0,05
Q14 *(cor. coef.)*	0,45	0,09	0,08	0,11	0,32	-0,11	0,02	-0,29	-0,10	-0,04	0.65**	0,34	-0,03	1,00	0,41	0,40	0,18
Sig.level	0,07	0,74	0,77	0,67	0,21	0,69	0,93	0,25	0,69	0,87	0,00	0,18	0,90		0,10	0,12	0,49
Q15 *(cor. coef.)*	0,48	0,09	0,05	0.54*	0,09	0,00	-0,18	0,00	0,09	0,27	0,04	0.49*	0,27	0,41	1,00	0,13	-0,22
Sig.level	0,05	0,72	0,86	0,02	0,74	0,99	0,49	0,99	0,74	0,29	0,88	0,05	0,29	0,10		0,63	0,40
Q16 *(cor. coef.)*	0,36	0,31	0,03	-0,03	0,07	-0,35	0,31	-0,26	-0,46	-0,09	0,23	-0,01	0,45	0,40	0,13	1,00	-0,02
Sig.level	0,16	0,23	0,91	0,92	0,79	0,17	0,22	0,31	0,07	0,73	0,38	0,96	0,07	0,12	0,63		0,95
Q17 *(cor. coef.)*	0,01	-0,34	0,25	-0,01	-0,08	-0,16	0,31	-0,13	0,14	-0,12	0,28	-0,40	-0.48*	0,18	-0,22	-0,02	1,00
Sig.level	0,98	0,18	0,34	0,98	0,77	0,54	0,23	0,62	0,60	0,64	0,28	0,11	0,05	0,49	0,40	0,95	

Note: (*) and (**) denotes 2-tailed significance

Table A-2: Spearman rho non-parametric Correlation Analysis, 12-TTF item Construct

Constructs		DQ	ME	LO	AC	EU	CU	SR	CO	AS	LD	PR	AU
DQ	Coefficient	1,00	0,23	0,23	-0,11	0,10	-0,67	0,23	1.00**	0,23	0,78	0.89*	1.00**
	Sig. level		0,71	0,71	0,89	0,87	0,22	0,71		0,71	0,22	0,04	
ME	Coefficient	0,23	1,00	1.00**	0,26	-0,22	-0,78	1.00**	0,23	1.00**	1.00**	0,34	0,23
	Sig. level	0,71			0,74	0,72	0,12		0,71			0,57	0,71
LO	Coefficient	0,23	1.00**	1,00	0,26	-0,22	-0,78	1.00**	0,23	1.00**	1.00**	0,34	0,23
	Sig. level	0,71			0,74	0,72	0,12		0,71			0,57	0,71
AC	Coefficient	-0,11	0,26	0,26	1,00	0,80	-0,40	0,26	-0,11	0,26	0,00	-0,11	-0,11
	Sig. level	0,89	0,74	0,74		0,20	0,60	0,74	0,89	0,74	1,00	0,89	0,89
EU	Coefficient	0,10	-0,22	-0,22	0,80	1,00	0,00	-0,22	0,10	-0,22	0,11	0,21	0,10
	Sig. level	0,87	0,72	0,72	0,20		1,00	0,72	0,87	0,72	0,89	0,74	0,87
CU	Coefficient	-0,67	-0,78	-0,78	-0,40	0,00	1,00	-0,78	-0,67	-0,78	-0,74	-0,56	-0,67
	Sig. level	0,22	0,12	0,12	0,60	1,00		0,12	0,22	0,12	0,26	0,32	0,22
SR	Coefficient	0,23	1.00**	1.00**	0,26	-0,22	-0,78	1,00	0,23	1.00**	1.00**	0,34	0,23
	Sig. level	0,71			0,74	0,72	0,12		0,71			0,57	0,71
CO	Coefficient	1.00**	0,23	0,23	-0,11	0,10	-0,67	0,23	1,00	0,23	0,78	0.89*	1.00**
	Sig. level		0,71	0,71	0,89	0,87	0,22	0,71		0,71	0,22	0,04	
AS	Coefficient	0,23	1.00**	1.00**	0,26	-0,22	-0,78	1.00**	0,23	1,00	1.00**	0,34	0,23
	Sig. level	0,71			0,74	0,72	0,12		0,71			0,57	0,71
LD	Coefficient	0,78	1.00**	1.00**	0,00	0,11	-0,74	1.00**	0,78	1.00**	1,00	1.00**	0,78
	Sig. level	0,22			1,00	0,89	0,26		0,22				0,22
PR	Coefficient	0.89*	0,34	0,34	-0,11	0,21	-0,56	0,34	0.89*	0,34	1.00**	1,00	0.89*
	Sig. level	0,04	0,57	0,57	0,89	0,74	0,32	0,57	0,04	0,57			0,04
AU	Coefficient	1.00**	0,23	0,23	-0,11	0,10	-0,67	0,23	1.00**	0,23	0,78	0.89*	1,00
	Sig. level		0,71	0,71	0,89	0,87	0,22	0,71		0,71	0,22	0,04	

Note: (*) and (**) denotes 2-tailed significance level at 5% and 1% respectively.

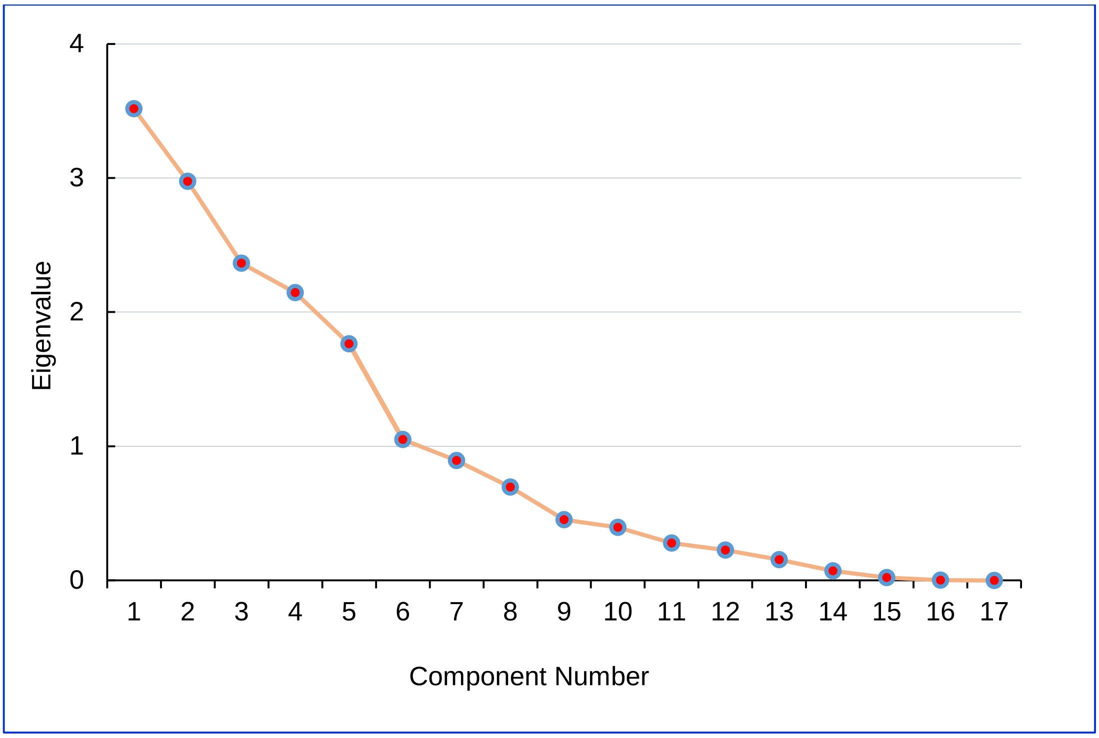

Figure A-1: Scree Plot of Factors Extracted (Full sample) *Source: Author*

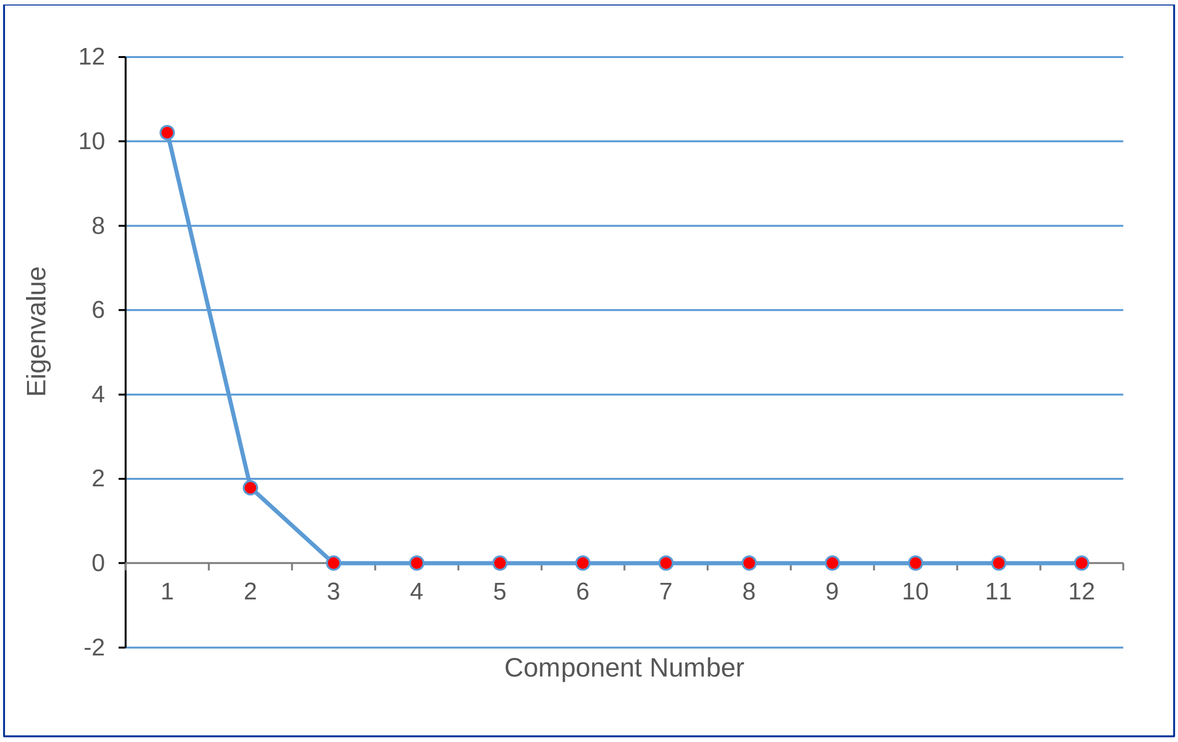

Figure A-2: Scree Plot for 12 TTF Constructs. *Source: Author computation from SPSS*

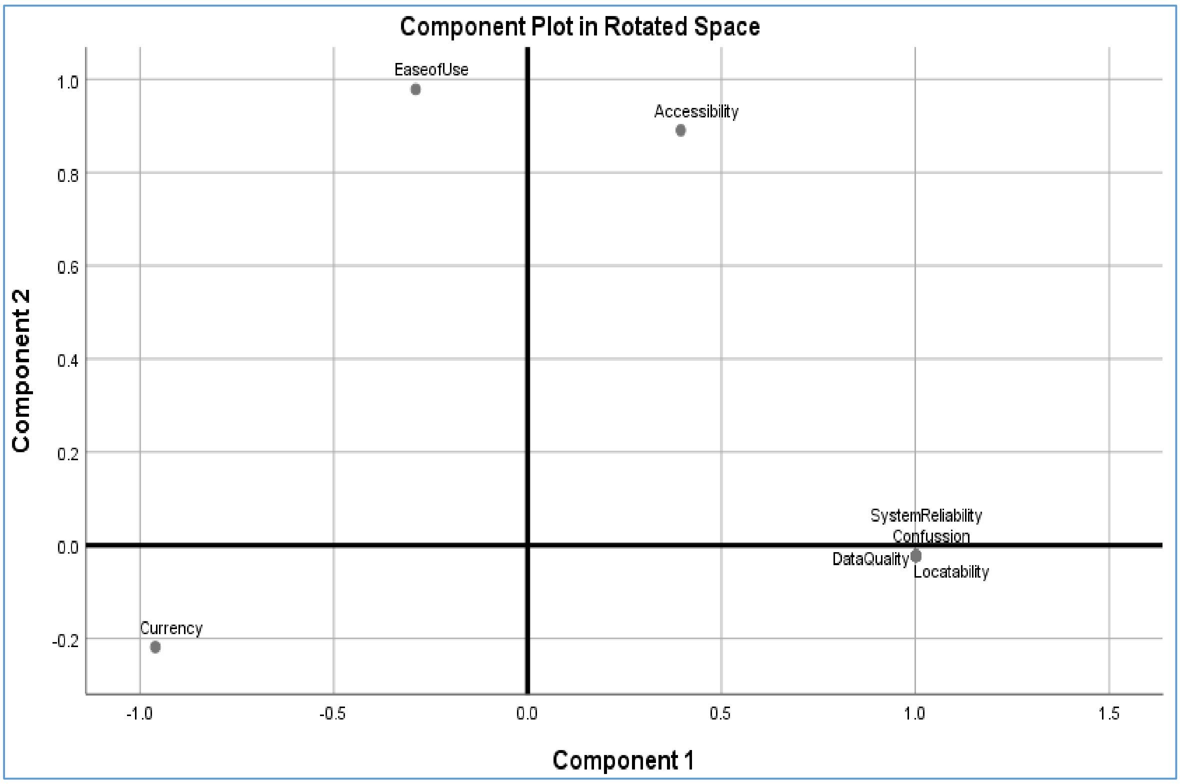

Figure A-3: Space Rotation of the 12-TTF constructs. *Source: Author computation from SPSS*

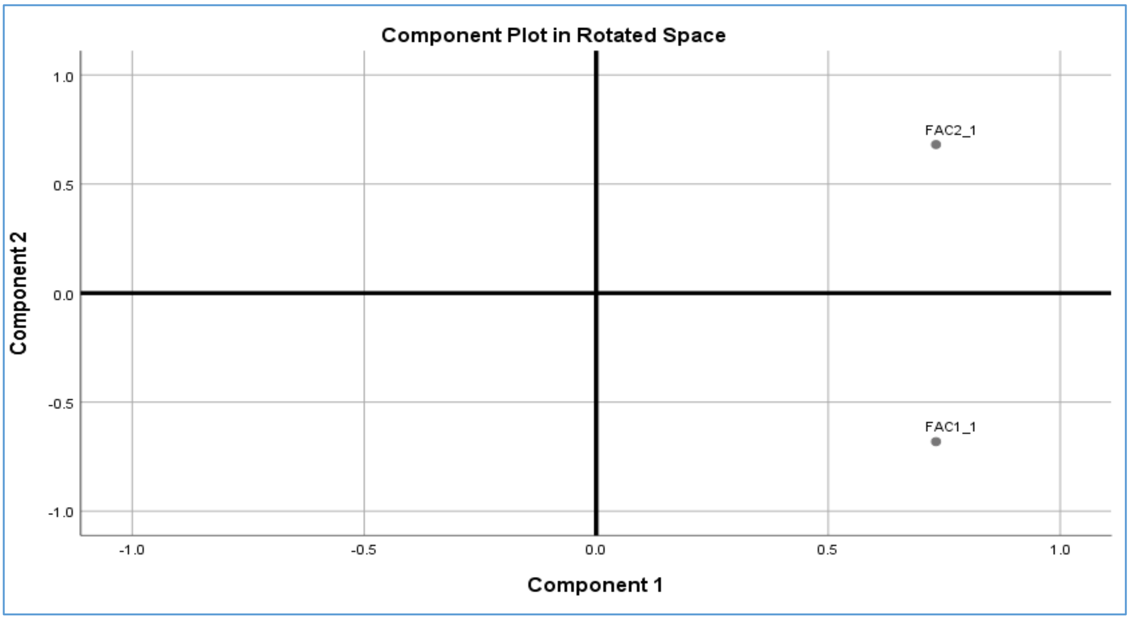

Figure A-4: Space rotation of extracted latent factors from the 12-TTF *Source: Author*

Appendix II – Questionnaire

Questionnaire for Master's Degree: Assessing the effectiveness of the business intelligence system within the Free State government departments: Task Technology Fit perspective

RESEARCH INVITATION LETTER

Dear ________________________,

I am pleased to invite you to participate in an interview to assess the success of the implementation VULINDLELA for business intelligence purposes within Free State government departments. No more than **thirty minutes** would be required to complete the interview.

Be assured that any information you provide will be treated in the strictest confidence and your participation will only be identifiable in the resulting report with your consent. You are entirely free to discontinue your participation at any time or to decline to answer particular questions.

I will seek your consent, on the attached form, to **record the interview** and to use the recording in preparing the report. I give the assurance that this will only be used for purpose of research.

Thank you for your assistance.

Ms. TEM Moloabi, Researcher

Central University of Technology, Free State, South Africa

INTERVIEW GUIDE

The purpose of the interview is to identify the Business Intelligence aspects of VULINDLELA and the extent to which these aspects support the day-to-day decision-making processes in Free State government departments.

The researcher/research assistant will:-

1. Introduce the interview session by explaining the purpose of the interview, welcome the respondent(s) and make clear why they were chosen.
2. Explain the presence and purpose of any recording equipment and give the option for respondent**(s)** to opt out of recording.
3. Outline ground rules and interview guidelines such as participants can end the interview at any time or refuse to answer any questions,
4. Inform the respondent**(s)** that a break will be provided if time goes beyond 30 munities.
5. Address the issue of privacy and confidentiality and inform the respondent**(s)** that information gathered will be analyzed aggregately and respondent's personal details will not be used in any report. The researcher will also make it clear those respondents' answers and any information identifying the respondent**(s)** as a participant of this research will be kept confidential.
6. Inform the respondent**(s)** that they must sign consent forms before the interview begins.
7. Inform the respondent**(s)** that the interview consists of **17 questions**, some with sub sections.
8. Inform the respondent**(s)** how to provide answers to questions by either putting a mark on a check box for optional questions or by giving a short answer for open ended questions.
9. Inform the respondent**(s)** that during or after the interview additional questions can be asked to clarify respondent**(s)** answer.
10. Inform respondent**(s)** that they may choose not to answer a particular question; in that event, he will need to inform the researcher or research assistant.
11. Inform the respondent**(s)** that oral interview will be recorded to ensure responses are captured and transcribed accurately.
12. Inform the respondent**(s)** that they are allowed ask questions before, during and after the interview
13. Go through the process of completing a questionnaire with the respondent(s) through as an example
14. Inform the respondent(s) of follow-up activities and that they should provide their contact details at the end of the questionnaire if they may wish to be involved in the implementation phase of the research.
15. Assist the respondent(s) to properly fill the questionnaires to competition.
16. Collect all the questionnaire from the respondent(s)
17. Close the interview by thanking the respondent(s), maintaining on privacy and confidentiality considerations;

CONSENT FORM		
I, the undersigned, confirm that (please tick box as appropriate):		
[1]	I have read and understood the information about the research,	☐
[2]	I have been given the opportunity to ask questions about the research and my participation.	☐
[3]	I voluntarily agree to participate in the research.	☐
[4]	I understand I can withdraw at any time without giving reasons and that I will not be penalized for withdrawing	☐
[5]	The procedures regarding confidentiality have been clearly explained to me.	☐
[6]	If applicable, separate terms of consent for forms of data collection have been explained and provided to me.	☐
[7]	The use of the data in research, publications, sharing and archiving has been explained to me.	☐
[8]	I understand that other researchers will have access to this data only if they agree to preserve the confidentiality of the data and if they agree to the terms I have specified in this form.	☐
[9]	Select only **ONE** of the following:	
	• I would like my name used and understand what I have said or written as part of this research will be used in reports, publications and other research outputs so that anything I have contributed to this project can be recognised.	☐
	• I do not want my name used in this research.	☐
[10]	I agree to sign and date this informed consent, along with the Researcher.	☐

_______________________ ______________ ______________

Name of Respondent Signature Date

_______________________ ______________ ______________

Ms. TEM Moloabi, Researcher Signature Date

PART A: DEMOGRAPHIC INFORMATION	
Q 1	Date:__________________________________
Q 2	Names:____
Q 3	Department Name:____
Q 4	Job Title ❑IT Manager ❑Finance Officer ❑HR Director ❑IT Data Clerk ❑Other. Please specify ____
Q 5	Contact Details: Phone Number____ Email address____

PART B: KNOWLEDGE AND USE OF VULINDLELA

Q 6 **Below are the main modules of** Vulindlela, please select the ones that you use in your decision-making activities

Vulindlela System					
	Daily	**Weekly**	**Monthly**	**Quarterly**	**Annually**
Financial Application	❑	❑	❑	❑	❑
Human Resources	❑	❑	❑	❑	❑
Dashboards	❑	❑	❑	❑	❑
Supply chain	❑	❑	❑	❑	❑
Municipalities	❑	❑	❑	❑	❑
Health Applications	❑	❑	❑	❑	❑

System Performance					
	Extremely satisfied	**Require room for improvement**	**Neutral – No Opinion**	**Satisfied, but room for improvement**	**Extremely satisfied – no problems**
User friendly	❑	❑	❑	❑	❑
Ease to find report	❑	❑	❑	❑	❑
SCOA classification clear	❑	❑	❑	❑	❑
Clear functions	❑	❑	❑	❑	❑
Quality of reports	❑	❑	❑	❑	❑
Layout of the report	❑	❑	❑	❑	❑
Page open with ease	❑	❑	❑	❑	❑

Supply Chain Management			
	Satisfactory	**Not Satisfactory**	**Need Improvement**

Financial Reports	❑	❑	❑
Analytical reports	❑	❑	❑
Easy to make decision on the report	❑	❑	❑
Updated reports	❑	❑	❑

Human Resources Management					
	Strongly Agree	**Disagree**	**Not satisfied with**	**Satisfied with outcome**	**Extremely satisfied – no problems**
Editable reports	❑	❑	❑	❑	❑
Analytical reports	❑	❑	❑	❑	❑
SCOA classification clear	❑	❑	❑	❑	❑
Clear functions	❑	❑	❑	❑	❑
Quality of reports	❑	❑	❑	❑	❑
Layout of the report	❑	❑	❑	❑	❑
Page open with ease	❑	❑	❑	❑	❑
Tasks dependent on system	❑	❑	❑	❑	❑

IT Functionality					
	Yes	**No**	**Not Sure**	**Difficult**	**Extremely satisfied**
User friendly	❑	❑	❑	❑	❑
Use analytic generating tool	❑	❑	❑	❑	❑
Integrated to any system	❑	❑	❑	❑	❑
Dashboard Used	❑	❑	❑	❑	❑
Web-Based	❑	❑	❑	❑	❑

Intelligent Agent	❑	❑	❑	❑	❑
Accuracy of analysis	❑	❑	❑	❑	❑
Financial Analysis tool	❑	❑	❑	❑	❑
Enhance Decision tools	❑	❑	❑	❑	❑

OTHER FUNCTIONS		
	Agree	**Disagree**
Are functions of Vulindlela system adequate?	❑	❑
Are functions of system useful?	❑	❑
Do the capability of the system compatible with your decision task profile?	❑	❑
The function of Vulindlela make the performance of decision tasks to be easy?	❑	❑
Do you often need system to assist you to complete unstructured decision tasks?	❑	❑
Do you solve decision problems that are non-routine	❑	❑
Are your decision tasks dependent of the receiving accurate information from colleagues?	❑	❑
Does Vulindlela system integrate with other systems?	❑	❑

Q7 List the day to day tasks that you carry out as a manager and the extent to which Vulindlela assists you in executing these tasks?

TASKS/ACTIVITIES	1	2	3	4	5
1.	☐	☐	☐	☐	☐
2.	☐	☐	☐	☐	☐
3.	☐	☐	☐	☐	☐
4.	☐	☐	☐	☐	☐

5.	☐	☐	☐	☐	☐
6.	☐	☐	☐	☐	☐
7.	☐	☐	☐	☐	☐
8.	☐	☐	☐	☐	☐
9.	☐	☐	☐	☐	☐
10.	☐	☐	☐	☐	☐

Q8 Your comments

If there any other features you would like the system to have to make your decision-making effective?

____

Appendix III – Ethical Clearance

FACULTY RESEARCH AND INNOVATION COMMITTEE

RESEARCH ETHICS APPROVAL LETTER

Date:

This is to confirm that:

Applicant's Name	Ms TE Moloabi
Supervisor Name for Student Project (where applicable)	Dr EM Masinde
Level of Qualification for Student Project (where applicable)	Masters in IT
Tittle of research project	Assessing the effectiveness of the business intelligence system within the Free State government departments: Task Technology Fit perspective.

Ethical clearance has been provided by the Faculty Research and Innovation Committee on 22 June 2017 in view of the CUT Research Ethics and Integrity Framework, 2016 with reference number FEIT 2/17 - 6:13/22-6-17.

The following special conditions were set:

[X] None

[ ] Specific conditions

We wish you success with your research project.

(FRIC Chairperson)

Appendix IV - Research Permission Letter

treasury
FREE STATE PROVINCE

Mr. MNG Mahlatsi
Head of Department
Free State Provincial Treasury
Bloemfontein
9300

REQUEST FOR PERMISSION TO CONDUCT RESEARCH WITHIN THE FREE STATE PROVINCIAL DEPARTMENTS TOWARD MASTERS DEGREE IN ENGINNERING AND INFORMATION TECHNOLOGY

1. I Tanki E.M Moloabi Persal number 82234787 hereby request permission to conduct a research within the **Free State Provincial Treasury**, **COGTA and Health** departments to complete my Master's Degree with Central University of Technology (FS) in the field of Engineering and Information Technology. The research will be conduct for the purpose of my studies only.

2. My Proposal was approved on the October 2016 to proceed with the Dissertation. The title of my dissertation is "**A tool to assess the success of business intelligence implementations within Free State government departments: Task technology fit perspective**".

3. The Questionnaire and Interviews will be used as the methodology to gather information on the systems used within the department. A sample of participants will be chosen for the Senior Management and system users of the Departments in Study. All information gather will only be used for the purpose of the study only.

4. The contact session with the Supervisor will be discussed in January 2017 upon registration. It must be noted that the studies are self-paid as am still repaying the Department for the bursary that was provided during the beginning of my Masters studies at Pretoria University.

5. Hope you find all in order.

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SUBMITTED BY:

MS. T.E.M. Moloabi

Deputy Director: Departmental IT
Date: 15 / 12 / 2016

APPROVED/ ~~NOT APPROVED/ NOTED:~~

HOD: Provincial Treasury
Mr. MNG. Mahlatsi
Date: 20 / 12 / 2016