



SCHOOL OF MANAGEMENT SCIENCES
DEPARTMENT OF BUSINESS MANAGEMENT

***A CONTEXT-AWARE BUSINESS INTELLIGENCE
FRAMEWORK FOR SOUTH AFRICAN HIGHER
EDUCATION INSTITUTIONS***

Candidate Name: Alfred Mutanga

Student No: 11640358

PROMOTER: Prof. Armstrong Kadyamatimba

CO-PROMOTER: Prof. Nehemiah Mavetera

CO-PROMOTER: Dr Jannie. J. Zaaiman

**A Thesis submitted in Partial fulfilment of the Requirements of a Doctor of
Philosophy Degree in Business Management, Department of Business Management,
School of Management Sciences, University of Venda**

November, 2016

Declaration

I Alfred Mutanga declare that this thesis with the title “**A Context-Aware Business Intelligence Framework for South African Higher Education Institutions**” is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I, further declare that this thesis hereby submitted by me in partial fulfilment of the requirements for the Doctor of Philosophy Degree at the University of Venda has not been previously submitted for a degree at this university or any other university.

Alfred Mutanga

11640358



25 November 2016

PhD Candidate Name

Student No:

PhD Candidate: Signature and Date

Professor Armstrong Kadyamatimba

PhD Promoter



5 December 2016

PhD Promoter: Signature and Date

Professor Nehemiah Mavetera

PhD Co-Promoter



5 December 2016

PhD Co-Promoter: Signature and Date

Dr Jannie J. Zaaiman

PhD Co-Promoter



5 December 2016

PhD Co-Promoter: Signature and Date

Dedication

I dedicate my thesis work to my family and many friends. A special sentiment of appreciation goes to my late parents, Ellison and Gaudencia Mutanga, whose words of inspiration and ambition for tenacity always buzz in my ears. My sisters Mirirai, Miriam, Medium, Florence and young brother Trust Antony, have never left my side and are very special. I also dedicate this thesis to my many friends and family who have supported me throughout the process. I will always appreciate all they have done, especially my in-law Munashe Antony and my cousin brother Tendayi Mutangadura for reassuring me of my technology skills and capabilities.

I also dedicate this work and give special thanks to my wife and best friend Caroline N. Mutanga and my wonderful children Milagro, Ellison, Alfred and Ainsley for being there for me during the course of the whole doctoral program. I appreciate that all of you have been my best cheerleaders.

Acknowledgements

First and foremost, I would like to thank my Promoter Professor Armstrong Kadyamatimba for the scientific and professional guidance during the period of research and thesis writing. I appreciate his guidance, especially making me aware of the scientific requirements for a doctoral research. I also owe my deepest gratitude to the Co-promoters of this study, Dr Jannie Zaaiman and Professor Nehemiah Mavetera. They all rendered academic and professional advice during my doctoral research. It would have been difficult to have this thesis ready without their professional and scientific support.

This work would not have been possible without the financial support from the University of Venda, Dr Maree Pather who assisted me in getting tuition fees from Tshwane University of Technology and Thys Lourens from Information Delivery and Statistical Consultancy (IDSC) Private Limited, for the FAM and APPM PowerHEDA modules. I would also want to thank the South African universities who gave me the ethical clearance certificates, and those which gave me permission to carry out my research with their staff. Though the process of obtaining the ethical clearance certificates and approvals was a tedious one, the staff involved in the ethical applications and approvals were very helpful. I cannot thank every gatekeeper and everyone who responded to the survey but, this research would not have been completed without their support.

I am also heartily thankful to all my friends who supported me in any respect during my doctoral research and thesis writing, especially for all the encouragements they rendered to me. My special gratitude and sincere respect goes to my wife Caroline Nyasha, for the love, the burden of enduring the suffering and the tribulations with our four children during the past four years of research and thesis writing. I don't have any words to express the deep and emotional appreciation of what you endured and succumbed to. I could also not have achieved what I have achieved in life without the sacrifices that my late parents did for me. To my late father, Ellison Vavi and my late mother Gaudencia, I acknowledge all your sacrifices, I thank you. To all those who have contributed to my education Andrew Pande, Otilia Pande and Mirirai Mutanga, I say to you that this thesis is a testimony of the fruits of all your contributions. Finally, but not the least, I would like to acknowledge the support from my wife Caroline Nyasha and my four children Milagro Varaidzo, Ellison Vavi, Alfred Junior and Ainsley Anotidaishe, they were a fountain of my inspiration, throughout my doctoral research. A special acknowledgement to the Almighty, thank you Lord, for being there for me always forever and ever, Amen!

Abstract

This thesis demonstrates the researcher's efforts to put into practice the theoretical foundations of information systems research, in order to come up with a context-aware business intelligence framework (CABIF), for the South African higher education institutions. Using critical realism as the philosophical underpinning and mixed methods research design, a business intelligence (BI) survey was deployed within the South African public higher education institutions to measure the respondents' satisfaction and importance of business intelligence characteristics. The 258 respondents' satisfaction and importance of the 34 observed business intelligence variables, were subjected to principal components analysis and design science research to come up with the CABIF. The observable BI variables were drawn from four latent variables namely technology and business alignment; organizational and behavioural strategies; business intelligence domain; and technology strategies. The study yielded good values for all the observed satisfaction and importance business intelligence variables as indicated by the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and the Bartlett Test of Sphericity. The data set collected from the survey deployed at the South African public higher education institutions, was reliable and valid based on the **Cronbach α** values which were all above 0.9.

The researcher then used the descriptive and prescriptive knowledge of design science research, and the meta-inferences of the results from the principal components analysis to produce five contexts of CABIF. The BI contexts developed were, the Basic Context; the Business Processes Context which was divided into Macro and Micro business process contexts; the Business Intelligence Context; and the Governance Context. These contexts were extrapolated within the University of Venda's business processes and this researcher concluded that the CABIF developed, could be inferred within the South African higher education institutions. At the University of Venda, this researcher managed to draw up CABIF based business intelligence tools that spanned from leveraging the existing ICT infrastructure, student cohort analysis, viability of academic entities, strategic enrolment planning and forecasting government block grants. The correlations and regression measures of the technology acceptance variables of the business intelligence tools modelled using CABIF at University of Venda, revealed high acceptance ratio.

Overall, this research provides a myriad of conceptual and practical insights into how contextualised aspects of BI directly or indirectly impact on the quality of managerial decision making within various core business contexts of South African higher education institutions.

Key words: Business Intelligence, context-aware, design science research, mixed methods, meta-inferences, principal components analysis

Abbreviations

APPM: Annual Performance Plan Monitoring a PowerHEDA software application

BI: Business Intelligence

CABIF: Context-aware Business Intelligence Framework

CR: Critical Realism

DHET: Department of Higher Education and Training

DOE: Department of Education

DSR: Design Science Research

FAM: Financial Allocation Model a PowerHEDA software application

HEDA: Higher Education Data Analyser

HEI(s): Higher Education Institution(s)

ICT: Information and Communications Technology

IDSC: Information Delivery and Statistical Consultancy

IS: Information System

IT: Information Technology

ITS: Integrated Tertiary Software

KPA: Key Performance Area

KPI: Key Performance Indicator

LOB: Lines of Business

MM: Mixed Methods

MS: Microsoft

MSA: Measure of Sampling Adequacy

PCA: Principal Components Analysis

SA: South Africa

SAHEI(s): South African Higher Education Institution(s)

SDLC: System Development Life Cycle

SEP: Strategic Enrolment Planning

SEM: Strategic Enrolment Management

SQL: Structured Query Language

TAM: Technology Acceptance Model

Univen: University of Venda

Table of Contents

Chapter 1 : Introduction.....	1
1.1 Background to the Study	1
1.1.1 Need for Institutional Performance Reporting.....	2
1.1.2 Decline of Government Funding to Higher Education Institutions	3
1.1.3 South African Higher Education National Imperatives	3
1.2 Rationale for the Research.....	5
1.3 Justification of the Research.....	6
1.4 Critical Challenges facing the South African Higher Education	8
1.5 Research Setting	10
1.6 Problem Statement.....	12
1.7 Research Aim.....	13
1.7.1 Specific objectives	13
1.8 Research Questions and Hypotheses.....	14
1.9 Theoretical Lens Used to Understand the Research Space.....	16
1.20 Structure of the Thesis.....	17
1.21 Suggestions on Reading this Thesis.....	19
1. 22 Summary to Background and Introduction	20
Chapter 2 : Literature Review.....	22
2.1 Origins of Business Intelligence.....	22
2.1.1 Business Intelligence Advancements in Late 20 th Century	25
2.2 An Overview of Business Intelligence Frameworks.....	30
2.2.1 Business Intelligence Maturity Models.....	31
2.2.2 An Analysis of the Business Intelligence Maturity Models	41
2.2.3 Discussions of the Business Intelligence Maturity Models	44
2.3 Business Intelligence Maturity Levels in Organizations.....	51
2.3.1 Infusion of Business Intelligence in Higher Education	52
2.4 General Discussions on Context-Aware	60
2.4.1 Explanation of Context-aware computing	60
2.4.2 Attributes of Context-aware Systems	60
2.4.3 Variety of Computing Devices	61
2.4.4 Operations adjustment to the vicissitudes in the context of use.....	61
2.4.5 What is this researcher trying to achieve?	63
2.5 Discussions of the Literature Findings	63
2.5.1 Important Findings from the Literature.....	64
2.5.2 Lacunas in the BI Systems in SAHEs.....	65
2.5.3 An Attempt to Address BI Gaps in the South African Higher Education	66
2.6 Conceptual Context-Aware Business Intelligence Framework	67

2.7 Business Intelligence Systems Adoption Theories	69
2.8 Summary of the Literature Review	70
2.8 Concluding Remarks to the Literature Review	72
Chapter 3 : Context- Aware BI Framework Research Methodology	73
3.1 Introduction.....	73
3.2 An Overview of Information Systems Research	74
3.3 A General Description of Theory.....	75
3.3.1 General Types of Theory	76
3.4 Information systems Research Forms	78
3.4.1 Theoretical form of Research	78
3.4.2 Empirical Form of Research.....	78
3.5 Types of Research Tasks in Information Systems	79
3.5.1 Constructive Research Tasks	79
3.5.2 Nomothetic Research Tasks	79
3.5.3 Ideographic Research Tasks.....	80
3.6 Sociological Paradigms Applied to Information Systems Research.....	80
3.6.1 The Functionalist Paradigm.....	82
3.6.2 The Interpretive Paradigm.....	82
3.6.3 The Radical Structuralist Paradigm	83
3.7 Information Systems Research Philosophies.....	83
3.7.1 Ontological Grounding to Information Systems Research	84
3.7.2 Epistemological Grounding to Information Systems Research	85
3.7.3 The Humanistic Grounding in Information Systems Research.....	86
3.8 Critical Realism as the Philosophical Underpinnings of this Research	87
3.8.1 Epistemological Features of Critical Realism.....	88
3.8.2 Epistemological Fallacy.....	89
3.8.3 Distinction of Critical Realism from other Philosophical Research Paradigms	89
3.8.4 Critical Realism as the Philosophical Underpinning for this Research	90
3.9 Information Systems and Research Paradigms	91
3.9.1 Quantitative Research Paradigm.....	91
3.9.2 Qualitative Research Paradigm.....	92
3.10 Approaches to Information Systems Research	93
3.10.1 The Positivist Research Approach	93
3.10.2 The Interpretivist Research Approach	94
3.10.3 The Critical Realism Approach	95
3.11 The Diagnosis of the Nature of the Research Problem	95
3.11.1 Ontological Diagnosis	96
3.11.2 Epistemological Diagnosis	96
3.11.3 Humanist Diagnosis	96

3.11.4 Classification of the research questions	97
3.11.5 Hypotheses at the University of Venda.....	98
3.12 Research Design	98
3.12.1 Reasons for choosing Mixed Research Methods Design.....	100
3.13 Research Methods	102
3.13.1 Exploratory Study of BI in South African HEIs	103
3.13.2 Design Science Research for CABIF.....	112
3.13.3 Deployment of CABIF the University of Venda	115
3.13.3.1 Technology Acceptance Survey at the University of Venda.....	116
3.14 Data Analysis Preparation	119
3.14.1 The Pre-Test Data Analysis of the Business Intelligence Survey.....	119
3.14.2 Data Analysis Strategy.....	120
3.15 Summary of the Research Design and Methodology	124
Chapter 4 : Data Analysis - Results Presentation and Discussions	127
4.0 Introduction.....	127
4.1 Phase I - Pilot Data Analysis	128
4.1.1 Selection of Business Intelligence Factors to Load	129
4.1.2 Explanation of the Values of Communalities in the Pilot Data Analysis	129
4.2 Phase II – Quantitative Data Analysis of the Business Intelligence Survey	132
4.2.1 The Main Quantitative Data Analysis Process: Principal Components Analysis	133
4.2.2 The Analysis of the Business Intelligence Latent Variables	134
4.2.3 Business Intelligence Characteristics in South African Higher Education	140
4.2.4 Conclusions on Business Intelligence Satisfactory Measures Analysis	148
4.3 Analysis of the Business Intelligence Importance Measures	149
4.3.1 Reliability of Business Intelligence Importance Data Set	149
4.4 Phase III – Qualitative Data Analysis	154
4.4.1 Content Analysis of BI systems within SAHEIs.....	156
4.4.2 Content Analysis of BI Implementation Methodology.....	160
4.5 Theoretical Foundations of BI Systems in South African Higher Education.....	165
4.5.1 Business Intelligence Systems Used in South African Higher Education.....	165
4.5.2 BI Development Approaches in SAHEIs.....	166
4.5.3 Respondents' Satisfaction with BI in the South African Higher Education	168
4.6 Construction of Theoretical Bases for BI Systems in SA Higher Education.....	169
4.6.1 Conceptual foundations from Business Intelligence Satisfactory Measures	169
4.6.2 Concluding Remarks from Business Intelligence Satisfactory Measures	173
Chapter 5 : Design of the Context-aware Business Intelligence Framework.....	175
5.7.1 Introduction to the Implementation of Design Science Research.....	175
5.7.2 The development of the Business Intelligence Framework.....	177
5.7.3 Purpose and scope of the Context-aware Business Intelligence Framework.....	177

5.7.4 Literature Review of Descriptive Knowledge and Prior Prescriptive Knowledge	178
5.7.5 Design Science Research Methods	180
5.7.6 Integrating BI Knowledge Using Design Science Research.....	191
5.7.7 Description of the Context-aware Business Intelligence Framework	193
5.8 Summary of Context-aware Business Intelligence Framework	204
Chapter 6 : Context-aware Business Intelligence Framework Implementation	207
6.1 Introduction to CABIF implementation at the University of Venda	207
6.2 Selection of the Business Intelligence Technology	208
6.3 Case Study at University of Venda	209
6.3.1 The Architecture of the Business Intelligence System at Univen	209
6.3.2 Implementing the Context-aware Business Intelligence Framework.....	214
6.3.3 Detailed Responses to the Research questions at the University of Venda.....	217
6.3.4 Discussion of the TAM Survey Results at University of Venda	230
6.4 Methodological Inferences of Critical Realism on Mixed Methods Research.....	232
6.4.1 Ontological Impact of Critical Realism	232
6.4.2 Epistemological impact of Critical Realism	234
6.4.3 Validation of the Quality of Business Intelligence Inferences	235
6.5 Summary and Conclusions.....	238
Chapter 7 : Conclusions, Recommendations and Further Research	239
7.0 Introduction.....	239
7.1 Research Questions and Main Findings of the Study	239
7.1.1 South African Higher Education BI Systems Conceptual Foundations	240
7.1.2 Practical Foundations of South African Higher Education BI Systems.....	241
7.2 Implications of the Research Findings	250
7.2.1 Evaluation of the Theory Generated Through the Study.....	252
7.2.2 Research Quality Considerations	252
7.2.3 Contribution to the field of Business Intelligence System.....	253
7.2.4 Evaluation of the Study's Contribution to the Body of Knowledge.....	254
7.2.5 Overall Evaluation of the Thesis.....	263
7.3 Problems that arose during the Research.....	264
7.4 Limitations of the Study	265
7.5 Future Directions of the Study	266
7.6 Recommendations.....	267
7.7 Autobiographical Reflections	268
7.8 Concluding Remarks	269
References	270
Appendices	281
A1- Codebook Variable Explanations: BI Survey in South African Higher Education	281
A2- Codebook Business Intelligence Survey Items.....	282

A3- Codebook Data Dictionary: BI Survey in South African Higher Education	285
B1- Codebook Data Dictionary: Technology Acceptance Survey at University of Venda	288
B2- Codebook Variable Explanations: TAM Survey at the University of Venda.....	292
C1- Phase I - Results of Pilot Data Analysis: Satisfactory factors	293
C2- Phase I - Results of Pilot Data Analysis: Importance factors	294
D1- Phase II – Descriptive Statistics Quantitative Data Analysis: Satisfactory factors.....	295
D2 – Latent and Observed BI Variables Coding used in the Data Analysis.....	296
D3 – Latent and Observed Importance BI Variables Coding used in the Analysis	297
D4 – Latent and Observed Satisfactory BI Variables Coding used in the Analysis.....	298
D5 - Observed Importance Business Intelligence Variables Communalities	299
D6- Observed Satisfactory Business Intelligence Variables Factor Loadings.....	300
D7- Observed Satisfactory BI Variables Factor Loadings Rotated Component Matrix	301
D8- Inter- Correlation Matrix of BI Satisfactory Variables	302
D9- Anti-image Correlation Matrix of BI Satisfactory Variables (MSA)	303
D10- Total Variance of Observed BI Satisfactory Variables	304
D11- Varimax Rotated Components Matrix for BI Satisfactory Measures	305
D12- Correlation Matrix for the BI Importance Measures	306
D13- Anti-image Correlation Matrix of BI Importance Components (MSA).....	307
D14- Rotated Component Matrix of BI Importance Components	308
D15- Total Variance of Observed BI Importance Variables.....	309
D16- Cohort Analysis for the 2005 First Time Cluster Enrolment.....	310
D17: Strategic Enrolment Planning at the University of Venda	311
D18- Dashboard for Monitoring the Strategic Enrolment Plan at University of Venda	313
D19- Complete University of Venda Business Intelligence Solution.....	314
D20 - ITS Views Data Warehouse Architecture at University of Venda.....	315
E1: Financial Viability Academic Entities at Univen for 2011-2012 Academic Years.....	320
E2: IDSC Letter for PowerHEDA applications.....	321
E3: University of Venda Government Funding Allocation for 2014/2015.....	322
E4: Correlations of the TAM Survey variables at University of Venda.....	324
F1 - Ethical Clearance Certificates from South African Higher Education Institutions	325
F2 - Cover Letter	346
F3- Editing Report	348

List of Figures

Figure 1.1: South African Higher Education Legislative Framework	11
Figure 2.1: Conceptual Context-Aware Business Intelligence Framework.....	68
Figure 3.1: Mixed Methods Research Design.....	99
Figure 3.2: The Roles of Knowledge in Design Science Research (Gregor & Hevner, 2013)	114
Figure 3.3: Technology Acceptance Model	117
Figure 4.1: Business Intelligence The latent and observed variables	134
Figure 4.2: Business intelligence Satisfactory Components Plot in Rotated Space	145
Figure 4.3: Scree Plots for Business Intelligence Satisfactory Factors	146
Figure 4.4: Scree Plots for Business Intelligence Importance Factors	151
Figure 4.5 Business intelligence Satisfactory Components Plot in Rotated Space	152
Figure 4.6: Distribution of Key BI systems within SAHEIs	157
Figure 4.7 : Business Intelligence Systems in SAHEIs.....	158
Figure 4.8: Distribution of Key words for BI Systems within SAHEIs	159
Figure 4.9: Usage of BI systems within the SAHEIs	160
Figure 4.10: Frequency of BI Methodological Terms	162
Figure 4.11: Distribution of key BI Methodological Terms within SAHEIs	163
Figure 4.12: BI Methodological Views within SAHEIs.....	164
Figure 4.13: BI Development Methodologies in South African Higher Education.....	167
Figure 4.14: Respondents' Percentage Satisfaction with current BI System.....	169
Figure 4.15: Business intelligence Strategy BI Satisfactory Factor Loading	170
Figure 4.16: Institutional demand for analytics BI satisfactory factor loading	171
Figure 4.17: BI design, development implementation Satisfactory Loadings	172
Figure 4.18: People, business processes and institutional politics BI Satisfactory Loadings.....	173
Figure 5.1: Business Intelligence penetration enablement	182
Figure 5.2: Business Context and Key Institutional Performance Indicators	183
Figure 5.3: Data Architecture	184
Figure 5.4: Managerial Decisions and Actions Enablement.....	185
Figure 5.5: A Broad Set of Business Intelligence Stakeholders	186
Figure 5.6: Efficacy of Business Intelligence Technology Performance	186
Figure 5.7: Business Process Planning.....	187
Figure 5.8: Lines of Business Drivers for Business Intelligence.....	188
Figure 5.9: Business Intelligence Constraints and Assumptions.....	189
Figure 5.10: Business Intelligence Frameworks and Proven Methodologies	190
Figure 5.11: Business Context and Key Institutional Performance Indicators	191
Figure 5.12: Clustering the BI characteristics after Principal Components Analysis	192
Figure 5.13: Business Intelligence Skills Set.....	200
Figure 5.14: Context-aware Business Intelligence Framework	204
Figure 5.15: Detailed Context-Aware BI Framework for SAHEIs	206
Figure 6.1: Hard disk configuration of the BI Server infrastructure at the University of Venda	211
Figure 6.2: BI architecture implemented at University of Venda	212
Figure 6.3: Logical BI Architecture at University of Venda.....	214
Figure 6.4: DHET Strategic Enrolment Performance Monitoring Using CABIF	226
Figure 6.5: Pearson's Correlation Values between TAM variables	229
Figure 6.6: Stratified Business Intelligence Ontology for Critical Realism	233
Figure 6.7: The Retroductive Approach of Critical Realism for BI knowledge Creation.....	235
Figure 6.8: Research Validity based on Critical Realism	237

List of Tables

Table 2.1 Some Definitions of Business Intelligence	23
Table 2.2: Business Intelligence systems being implemented in higher education institutions.....	57
Table 3.1: Classification of the research questions	97
Table 3.2: Journal of Research Activities	108
Table 3.3: Journal for Technology Acceptance Survey at University of Venda	119
Table 3.4: Summary of Research Design and Methodology.....	125
Table 4.1: A Sample of Communalities for Business Intelligence Satisfactory Measures	130
Table 4.2: A Sample of Communalities for Business Intelligence Importance Measures	130
Table 4.3: Monte Carlo Principal Analysis for Parallel Analysis	131
Table 4.4: Communalities of the Business and Technology Alignment Satisfactory Dimension...	135
Table 4.5: Business and Technology Alignment Correlation Matrix	136
Table 4.6: Business and Technology Alignment Dimension Variance	137
Table 4.7: Communalities for the Organizational and Behavioural Strategies Dimension	138
Table 4.8: Organizational and behavioural strategies Correlation Matrix	139
Table 4.9: Business Intelligence Satisfactory Variables Inter-Correlation Matrix.....	142
Table 4.10: Measure of Sampling Adequacy and Bartlett's Test for BI Satisfactory Measures	143
Table 4.11: Reliability analysis of BI Satisfactory Factors.....	148
Table 4.12: Reliability analysis of BI Importance Factors	149
Table 4.13: Measure of Sampling Adequacy and Bartlett's Test for BI Importance Measures	150
Table 4.14: Content Analysis for BI Systems Used in SAHEIs	156
Table 4.15: Methodologies for BI Implementation within SAHEIs	161
Table 4.16: Business Intelligence Systems Used in South African Higher Education	166
Table 4.17: BI Development Approaches in South African Higher Education	166
Table 4.18: Descriptive Statistics for Current BI Systems.....	168
Table 4.19: Respondents' Satisfaction with current BI System.....	168
Table 5.1: Literature for South African Higher Education Legislative Framework	179
Table 5.2: Macro-process and Micro-process contexts in SA higher education	196
Table 6.1: Business Intelligence Technology Used in South African Universities	208
Table 6.2: Software Requirements for the BI System at University of Venda	210
Table 6.3: CABIF contexts for enrolment management at the University of Venda.....	215
Table 6.4: CABIF Contexts for Student Cohort Analysis.....	216
Table 6.5: Demographics of the Respondents at the University of Venda	228
Table 6.6: Reliability and Validity of the TAM data set.....	229

Chapter 1 : Introduction

1.1 Background to the Study

The higher education system in South Africa is currently undergoing major changes in response to a rapidly-changing social, economic and political environment. In particular, a new policy framework and the accompanying changes in funding and governance arrangements; changing patterns of demand for higher education; competition from a growing private higher education sector; and new arrangements for programme development, accreditation and quality assurance (Asmal, 2003a; CHE, 2013; Steyn & de Villiers, 2011). This research study focuses on the need for theoretical and practical foundations for business intelligence (BI) systems in the South African higher education sector. This researcher summatively defines BI as an analytical, technology aided process which collects and transforms disparate institutional data assets into information or knowledge about strategic objectives, opportunities and environmental positions of an institution. The various definitions of BI will be shown later in Chapter 2 and in Table 2.1 to be more specific. In South Africa, the change agenda which centres on the development of a higher education system that is planned, governed and funded as a single co-ordinated system, is outlined in the Education White Paper 3: A Programme for the Transformation of Higher Education (CHE, 2000; DHET, 2013).

The successful implementation of the change agenda with its shift away from a demand-driven, uncoordinated system to a unified, planned system, has a profound influence on the shape and nature of the higher education system. In the case of the strategic and institutional planning processes, information systems are required to draw up data to fulfil the different features of the national and institutional imperatives. This researcher's view is that, higher education institutions need a Context-aware Business Intelligence framework (CABIF), to assist them in aligning their core business processes and information technology. Operationally, this researcher defines CABIF as a situated set of concepts, techniques, tools, ideas or facts that provide support for business intelligence initiatives within the South African higher education institutions (SAHEIs). Moreover, the advocates for BI activities within the South African higher education institutions should be aware, should have knowledge, or be conscious or cognizant of each institutional context subjected to BI activities. Under the auspicious of CABIF, through knowledge, institutions create their own business decisions and operations by using BI. Consequently, BI becomes an important ingredient for institutional strategic performance.

1.1.1 Need for Institutional Performance Reporting

In order to develop such institutional plans and proposals advocated for by the Department of Higher Education and Training (DHET), and to monitor and evaluate their achievement, institutions need to compile a comprehensive array of statistical information. On 9 June 2014, the DHET published the Government Gazette No. 37726 which promulgated on new Regulations for Reporting by Public Higher Education Institutions (Nzimande, 2014a). In terms of the revised regulations each public higher education institution (HEI) must:

- a) Produce a Strategic Plan and update it at least every five years;
- b) Submit an Annual Performance Plan (APP) for year $n+1$ by 15 December of each year (15 January 2015 for 2015) to the DHET which must:
 - i. Be consistent with the Medium-Term Expenditure Framework (MTEF) period,
 - ii. Be aligned to the Institutional Strategic Plan
 - iii. Contain performance targets and core set of indicators to monitor institutional performance;
- c) Adopt a mid-year reporting system and submit a Mid-Year Performance Report
- d) Ensure alignment between the Strategic Plan, Annual Performance Plan, Annual Report, budget documents and Mid-Year Performance report

The BI systems in higher education should therefore connect and integrate data from a set of legacy systems to be able to monitor institutional performance. The Gartner's BI Maturity model advocated for a link of BI with organizational performance (Gartner, 2014). The BI systems within the SA higher education sector should be able to provide reports needed for Annual Performance Plan, Annual Report, budget documents and Mid-Year Performance report as needed by the DHET. The BI systems should be able to deliver institutional managers with strategic information on the actual progress versus the targets for key performance indicators (KPIs). Such information is invaluable for the compliance reports needed by the DHET, and to provide institutional managers with critical information to make informed decisions. The BI systems in the higher education have shown little or no integration with research management information systems. The DHET requires institutions to submit their research outputs on annual basis (Asmal, 2003b; DHET, 2012). This entails that data integration is a major activity to be accomplished by HEIs in South Africa.

1.1.2 Decline of Government Funding to Higher Education Institutions

In South Africa, the State funding for Teaching and Learning, Research and Innovation and other forms of subsidy have decreased in real terms with a larger responsibility on higher education institutions to mobilise additional funding sources. The 2015 Ministerial Statements on Funding for Universities shows a decline in major subsidy regimes as compared to the 2014 funding year (Nzimande, 2014b). Opportunities for partnerships with international universities has led to revised institutional strategies with respect to postgraduate training, research and innovation. Business intelligence systems can be implemented to predict the funding that each institution, will receive by modelling the funding to be allocated to the institution. This is achieved by collecting information that determine the teaching input units, teaching output units, research output units and determine the block grants (Asmal, 2003a, 2003b; Nzimande, 2014b).

The allocation of funds to universities depends largely on the Medium-Term Expenditure Framework (MTEF) which provides the DHET and universities with an overview of the three-year rolling budget process. This includes timelines for different activities and decision making points, leading to the approval of budget allocations and tabling of the Budget by the Minister of DHET to parliament. According to the current funding framework for higher education and SA universities in particular, the DHET relies heavily on the submitted student enrolment plans of universities, in order to submit budget proposals to the Treasury (DHET, 2014b; DoE, 2011; Steyn & de Villiers, 2011). BI systems within the SA higher education sector should therefore be able to exploit the descriptive knowledge from these statutory documents and bring forth reports that can assist institutions in financial planning, enrolment planning and putting in place effective and efficient teaching and learning strategies.

1.1.3 South African Higher Education National Imperatives

At national level, there are two important government policy documents in particular, that impact on the planning and structuring of programmes in universities. The “White Paper for Post-school Education and Training – Building an Expanded and Integrated Post-School System” (DHET, 2013) and the “National Development Plan 2030” developed by the National Planning Commission (Manuel & Ramaphosa, 2011). The major challenges for the higher education system of SA highlighted in the White Paper for Post-School Education and Training – Building an expanded and integrated post-school system include:

- Major increase in enrolment figures of universities, aiming for an enrolment of 1,6 million students by 2030
- Improved annual pass rates and graduation rates
- Strong focus on producing more Science, Engineering, and Technology (SET) graduates and completed post graduate studies
- Increased contributions to research and innovation
- An improved academic staff qualification profile with higher percentages of staff having doctorates

In the National Development Plan 2030 the major challenges have been articulated, and many of which also impacts on the role of higher education in SA. These include:

- Improving education, training and innovation by amongst others, increasing enrolment at universities by at least 70% by 2030, increasing to 1.62 million students
- Increase the number of students eligible to study towards mathematics and science based degrees to 450 000 by 2030
- Increase the percentage of staff qualified with doctoral degrees in the higher education sector from the current 34% to over 75% by 2030
- Produce more than 100 doctoral graduates per million per year by 2030. This implies an increase from 1420 in 2010 to well over 5 000 per year.
- Expand science, technology and innovation outputs by increasing research and development spending by government and through encouraging industry to do so.

The Department of Higher Education and Training (DHET) has issued an important ministerial statement on student enrolment planning for universities for the period 2014/15 – 2019/20. The ministry has even gone further by stipulating the enrolment and efficiency targets for all the institutions and the sector over this period. The DHET's Ministerial Statement on Enrolment Planning 2014/15 - 2019/20 for Universities (DHET, 2014b), articulated on the enrolment and efficiency targets for the higher education sector for 2014/15 – 2019/20 and provides the following challenges by 2019:

- An increase in headcount enrolments
- First-time entering undergraduate students to grow
- In 2019 the proportion of headcount enrolments by major field of study should be 43% in SET, 30% in Business/ Management, 11% in Education and 16% in Other Humanities.

- A growth in distance headcount enrolments
- An increase in number of graduates
- An increase in research publication units
- Proportion of staff with doctorates to increase

The key performance targets mentioned in the documents above require SAHEIs to implement information systems capable of providing information for decision-making, policy formulation and provide information to support the execution of strategies within the higher education sector. The role played by BI systems in SAHEIs should not be underplayed. It is incumbent upon business intelligence systems and analytics to provide theoretical and practical technological tools to support decision-making processes within the institutions. This is a fundamental postulation to be made in this research study, because if the role of business intelligence is to be understood in its various incarnations, students, researchers and practitioners of MIS must have a broad understanding of business intelligence and its inherent predictive analytics characteristics.

1.2 Rationale for the Research

A number of higher education institutions in South Africa are falling below the expected proficiency levels in terms of their student success rates, graduation rates, enrolment targets, staff retention etc. (DHET, 2014b, 2014c; Piedade & Santos, 2010). Universities should be able to measure, monitor and understand their performances and be aware of the factors that play in student enrolment and tuition, staffing, finance, procurement and asset management (Briggs, 2014; Piedade & Santos, 2010). Universities are therefore obliged to develop information and communication technology (ICT) infrastructures, which enables the university management to get meaningful information that will help them make correct decisions and create suitable conditions for the success. When data is scattered across the university as isolated silos, solving the success puzzle becomes a mystery or a difficult process. Apart from leveraging existing technology investments, universities have to implement integrated ICT infrastructures that extract data from these silos and use analytics that will help the university management to understand the data and make informed decisions.

Every higher education institution is unique, as envisaged by their different vision and mission statements. The uniqueness might be as a result of the different modes of delivery

of the courses, which is contact, distance or a hybrid form of delivery that consists of both distance and contact modes of delivery. The uniqueness might due to their defined niche areas which might be teaching and learning at undergraduate level or focussing on research. In such a complex environment, the standardization of the ICT infrastructure that supports decision making processes in the higher education institutions is, in most cases, dependant on the statutory obligations with which the institutions have to comply (Falamasir, Moaven, Abolhassani, & Habibi, 2010; Sharman, 2010). In South Africa, there are 26 public universities and each of these universities has to submit Higher Education Management Information System (HEMIS) statistics data to the Department of Higher Education and Training (DHET) three times a year (Skene, Bunting, De Beer, & Belding, 2009). The public higher education institutions (HEIs) rely financially on the subsidies and block grants given to them by the Department of Higher Education and Training (Nzimande, 2014b; Steyn & de Villiers, 2011). The HEMIS data is used by the DHET to allocate subsidies and block grants to the institutions.

Within this context, each university in South Africa will require an information system that assists with its data quality processes. The current administrative information systems in most of the universities are operating as disparate silos within their transactional and operational systems environments. In this research study this researcher examined the current theoretical, practical and methodological foundations behind the current BI systems used in South African Higher Education, and then developed a Context-aware Business Intelligence Framework that spans most of the core business data assets across the institutions. This researcher advocated for a BI system which has the capability for data discovery and of producing standard reports useful for university management to make informed decisions. This researcher realized that there was a gap within the SA higher education of a standardised approach to the design, development and implementation of BI systems.

1.3 Justification of the Research

The technology solutions and the business intelligence framework this researcher proposed in this research, strived to make sure that there is an increase in ICT efficiency including gains in university business efficiency and effectiveness. Whilst this researcher understands that universities are complex institutions, as every university's executive would probably testify, streamlining business processes and IT is crucial. Not only must the institutions be

managed in an increasingly constrained funding environment, but management must also report to a range of stakeholders; from students, staff, donors, Council for Higher Education (CHE), and to the Minister of Higher Education and Training. The standard and data quality supplied to these stakeholders vary from institution to institution. Of course, some data submitted to statutory bodies are standardized as they consist of the same variables and the data is extracted using prescribed software like the Validation Package (VALPAC) supplied to each institution by the DHET (Nzimande, 2012). VALPAC is software that enables South African higher education institutions to use for all the Student, Staff and Space collections for submissions to the DHET. It should be noted that, what varies from institution to institution are the standards and quality of the data sets submitted to these statutory bodies. This is because each institution has different data quality processes and data management processes in place. For example, in South Africa, the DHET expects institutions to submit quality HEMIS data to get valuable information for use in determining the funding of the public HEIs.

The South African higher education institutions treat HEMIS data as the official records of the institutions, though operational data is as vital for planning, quality assurance and policy formulation activities. This research study caters for gap in methodological implementations for BI systems in South African higher education. The premise for the implementation of a BI framework in SAHEIs, is to leverage the existing ICT investments at the institution by enabling a user-friendly web reporting and decision support modelling through the analysis of audited HEMIS and Operational data. This research suggests that a context-aware business intelligence framework is suitable for the SAHEIs.

The solution which this researcher proposed follow the conventional standards of Information systems development. This researcher undertook to develop and implement a BI technology solution that is scalable and enriched with additional variables to accommodate various management reporting needs. The extraction of these enrichment variables is managed by a structured management process which is incorporated in the proposed business intelligence framework. This is done in terms of generally accepted research doctrines in the form of technology and information systems research paradigms and the use of mixed methods research and validating the quality of meta-inferences.

1.4 Critical Challenges facing the South African Higher Education

The researcher is of the view that, there are ten critical issues affecting SA higher education, based on the “White Paper for Post-School Education and Training – Building an Expanded and Integrated Post-School System” (DHET, 2013) and the “National Development Plan 2030” (Manuel & Ramaphosa, 2011). These ten critical issues currently affecting the South African higher education include transformation of the higher education sector; a decrease in State funding of higher education; student persistence, retention and attrition issues; access to higher education; competition among higher education institutions; inadequacies in the education value chain; quality of higher education business processes; few human resource development initiatives; globalization and internationalization of higher education and laborious reporting requirements by HEIs. It was not the purpose of this study to delve into each one of these challenges but, they have a direct impact on institutional research, business intelligence and institutional planning activities within the higher education sector.

The tone for the vision for the transformation in higher education was set in the 1997 White Paper 3: A programme for the Transformation of Higher Education (WP3). The WP3 set the springboard for a single co-ordinated higher education system with new planning, governing and funding arrangements (DoE, 1997). It has been 19 years since the publication of the WP3, and still the South African higher education system embattles transformational obstacles. This is quite significant as this researcher had witnessed in 2015, the largest student social movement since the birth of South Africa’s democracy in 1994, through the ‘#RhodesMustFall’ and ‘#FeesMustFall’ movements. This quest for transformation in higher education moved to the heart of the national discourse, and was debated in the different sectors of the South African society. The #RhodesMustFall and #FeesMustFall movements stemmed from two major trials confronting the South African higher education which are alienation and access (Habib, 2016).

The students at the University of Cape Town (UCT) who started with the #RhodesMustFall movement, where they demanded for the removal of the statue of Cecil John Rhodes within the UCT campus, demonstrated the alienation of the largely black student population at UCT. The students sparked widespread concerns about institutional racism within the South African Universities. The transformation movements spread like veld fires to all historically White universities in South Africa and beyond doubt these sparked institutional governance challenges within these universities. The #RhodesMustFall and #FeesMustFall movements

is clear testimony that the vision of the WP3, and the strategic goals outlined in the National Plan for Higher Education (DoE, 2001), are not fully materialised. The #RhodesMustFall movement talks to one of the key issues in higher education that is the participation rate. In my opinion the alienation issue in higher education should not only address the issue of institutional racism, but to address the participation of previously marginalised members of society. Transformation in higher education, should address the participation by women, mature students, and the disabled.

The #RhodesMustFall and #FeesMustFall movements have transformed the South African higher education. These student movements have opened systematic institutional changes at most South African universities. The management at most universities are increasingly demanded to manage their institutions by fact. The roles of institutional research and BI are increasingly recognized as the universities use data to make decisions. Institutional research and BI are increasingly presenting student demographic data and equity information in most institutions. This data is used to inform the student recruitment strategies at the universities. The agenda for the de-racialization of the institutions is prompting institutional planning units at universities to set key performance indicators (KPIs) or targets for certain races. For example, in his inaugural speech on 27 February 2015 as the sixth Vice-Chancellor and Principal of Rhodes University, Dr Sizwe Mabizela addressed the issue of access at Rhodes University. To quote from his speech he said that:

“we must make Rhodes University accessible to academically talented students from diverse racial, social, cultural, economic and class backgrounds and provide them with the support they need to succeed.” (Mabizela, 2015).

Mabizela’s speech is a testimony to the quest for institutions to fulfil the mandates set in the WP3. However, the institutionalization of institutional research and BI systems in South African public higher education is still an area to implore. BI systems could provide insights into the historic patterns and trends of the student demographics. These statistics could be used for strategic enrolment planning and hence inform the institutional student recruitment strategies. It is not only the Vice-Chancellors’ will and need to fulfil the legislative and statutory obligations of the South African higher education system. It is also important for them to understand the legislative framework of the SA higher education and put systems in place to govern the institutions.

1.5 Research Setting

This researcher undertook the research in the South African public HEIs, in public universities to be more specific. Throughout this document if this researcher is referring to the South African higher education sector, or higher education institutions this researcher will be referring to the South African public universities. As mentioned earlier, SAHEIs have to comply with different statutory regulations and legislature. These consortiums of regulatory and compliance policies, procedures and legislature, are herein referred to as the legislative framework of the South African higher education system. The legislative framework that the higher institutions in South Africa are required to comply include the Higher Education Act, DHET Programme Qualification Mix (PQM), National Qualifications Framework (NQF), Institutional Qualification Approvals, Professional Body Approvals, Regulatory Framework, Council on Higher Education (CHE) registration, South African Qualifications Authority (SAQA) registration, Quality Committee and the Higher Education Quality Sub-Framework (HEQSF).

The South African higher education legislative framework promotes reforms in higher education and training which relate to the vital parts of the current market economy. It is quite evident from the various legislative, policy and procedures documents that South Africa has made positive reform strides since 1994. However, the South African higher education is faced by the challenge of meeting the demands of the youth and the adult population amidst the wave of the market economy. The higher education legislative framework covers the reviews of higher education policies which embraces the whole education system, from early childhood to higher and tertiary education, and the entire education system is analysed based on its economic, social and political impact.

This research proposes that, the BI systems at the SAHEIs should provide compliance information and assist institutions in the external auditing requirements. The role of BI under such legislative and statutory imperatives for higher education institutions should not be underestimated. Under such a strictly controlled and monitored environment, each institution has to develop meaningful business cases on how it will fulfil its enrolments, graduates, research outputs and the financial obligations demanded by the DHET. The BI systems are therefore inevitably indispensable for the institutional decision-making, strategic planning, risk management, competitive advantage, efficiency gains, ranking and performance benchmarking among others. BI will assist institutional decision makers to make better and

more informed decisions that will guide the institutions in fulfilling their mandates. This researcher, will show that the CABIF addresses most of these statutory and legislative obligations. The CABIF sift through the various institutional contexts being addressed in the legislative, procedure and policy documents, and incorporate them in the identified BI contexts. In this study, this researcher advocated that the CABIF should be able to theorise and put into practice the symbiotic relationship between strategic planning and risk management. Figure 1.1 shows the legislative framework that SA institutional programmes need to comply with.

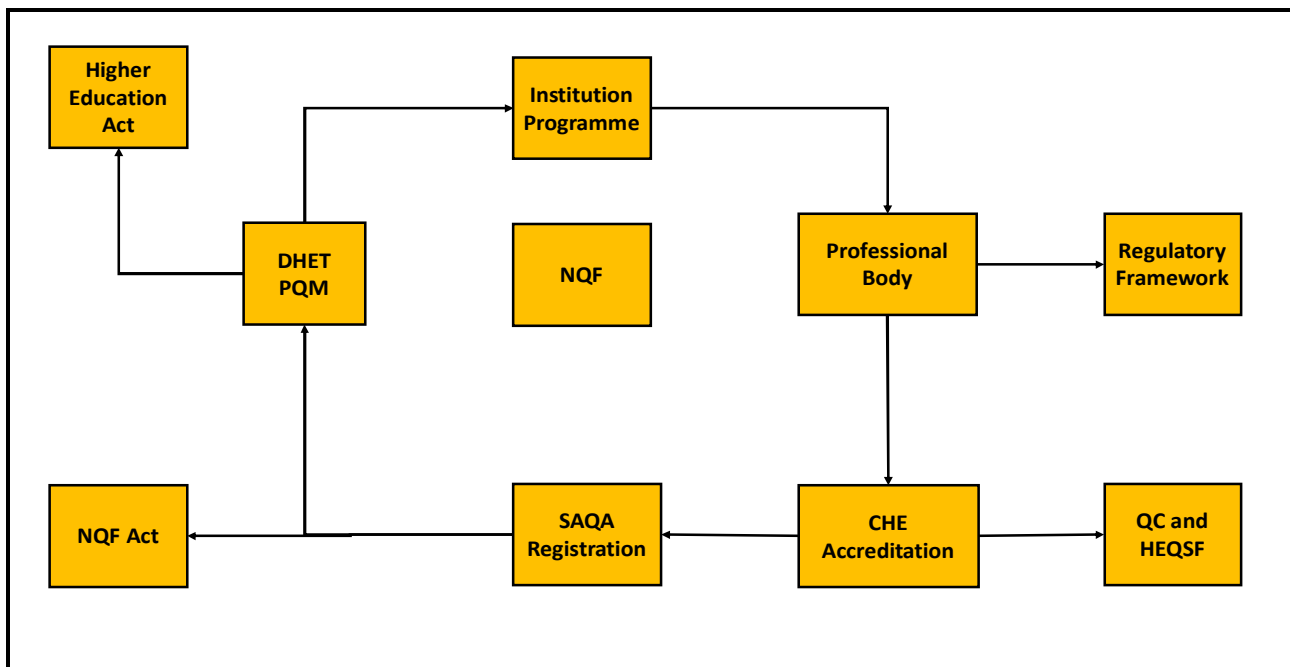


Figure 1.1: South African Higher Education Legislative Framework

This researcher viewed CABIF as a theory, unless it was put into use and tested for its adoption within the South African Higher Education. By theory, this researcher means, a supposition or a system of ideas, intended to explain BI within the South African higher education institutions, especially one based on general BI principles independent of the institutional business processes to be explained. This researcher therefore, implemented the CABIF at the University of Venda, with the aim of covering most of the theories, concepts and constructs this researcher proposed in the framework. For this reason, the study included all the activities related to the implementation of the CABIF as a decision-making process, and empirically and theoretically tested the technology acceptance and adoption of the BI solution at the University of Venda. The Technology Acceptance Model (TAM) was implemented as it was initially theorised and published (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989). This researcher assumed that the measurement of BI technology adoption

and acceptance at University of Venda could be replicated at any other public university in South Africa.

1.6 Problem Statement

In South Africa, given the shrinking government budget to Higher Education and the current economic environment, institutions need to provide high quality HEMIS data to attract government subsidy and block grants (DHET, 2014a; Nzimande, 2014b). The current harsh economic environment is not only affecting South African Higher Education institutions. Guster & Brown (2012) argued that data integration capability is non-existent in most higher institutions and that even though universities have large amounts of data at their disposal few university managers understand the benefits of BI. This situation has resulted in multiple data sources in institutions that often contradict each other and usually the data is unprocessed and therefore of little value in the institutional decision making activities (Briggs, 2014; Fish, 2014; Singh, 2015). The implementation of BI can have significant positive effects in the decision-making processes of the institution.

The implementation of BI initiatives in higher education using the one-size-fit-all approach does not work, hence this research advocates for contextualised or situated BI activities. The commonality in all BI implementations is the existence of a data warehouse, but designing a business intelligence system requires a contextualised, theoretical, practical and methodological approach rather than the conventional systems development paradigm. Critical to BI implementations are Information Systems research methodologies, which consider the business users among other elements (Parenteau, Chandler, Sallam, Laney, & Duncan, 2014; Sherman, 2015). In South Africa, higher education institutions are required to submit five-year enrolment plans to the DHET depending on the HEMIS statistics. These statistics are used by the DHET for sector planning and to project and forecast on the block grants and subsidies each institution must receive in predetermined financial year. It is questionable whether the institutions themselves can use BI technology resources to predict the subsidy and block grants from the government. It is even doubtful whether during their budget forecasting and elaboration processes that the higher education institutions factor in HEMIS statistics to predict the viability of the programmes and modules they are offering or intend to offer.

This researcher is of the opinion that, higher education institutions in SA will only be able to forecast the amount of government subsidy and grants they may receive, if BI technological

tools for predictive analytics of their current data assets are available. One might argue that the answer to this, is for the public higher education institutions is to invest in off-the-shelf BI tools that have been used in higher education for the past decade and, such as SAP Business Objects (SAP, 2015), IBM Cognos (IBM, 2010) and Infobuilder (Beckett & McComb, 2012). The researcher is of the opinion that, this is not the best practical approach, given the fact that each institution is unique and one-size-fits all approach to BI system implementation is not a pragmatic approach. Beckett & McComb (2012) presented the “Cycle of Continuous Improvement” as a possible means of using BI to deliver information and communicate strategy to various stakeholders within higher education institutions. This researcher agrees with Beckett and McComb, in that BI technology can be used strategically for performance management by connecting the institution’s strategy, retrieve and analyse data, and link with operational institutional processes in a continuous cycle.

It is not an easy task to make BI and management information to be vehicles for decision-making processes and performance management in the higher education sector, particularly in the South African higher education sector. Selecting a BI technology and linking it with the theoretical, practical and methodological conceptions of the business intelligence field and evaluating the technology choice through empirical means are often unheard-of in HEIs, especially in South Africa. The empirical and theoretical approach to the implementation BI systems in SAHEIs is the research gap that this researcher needed to undertake through this study.

1.7 Research Aim

The aim of this study was to develop and implement a CABIF for the South African higher education sector. The research aim substantiates the imperative to provide an accessible, secure management information system environment in a South African higher education environment.

1.7.1 Specific objectives

The following were the specific objectives:

- To identify and leverage the collective knowledge of business intelligence systems in the South African higher education sector in order to accommodate a context- based business intelligence framework for the sector;

- To use design science research as a means of developing a context-aware business intelligence framework suitable for the South African higher education sector;
- To evaluate the end-users' perceived technology adoption and acceptance of the rolled-out information system based on the developed context-aware business intelligence framework.

The BI solution this researcher proposed leveraged the collective knowledge of existing operational information systems to accommodate a university-wide management information system. The system establishes practices and processes for HEMIS and Operational data provision by standardizing the processes of data integration and dissemination on a web portal. In this process, the information system facilitated the establishment of a centralized system of official university data records that ensured legal compliance both for internal use and external reporting.

1.8 Research Questions and Hypotheses

Following the preceding statements and arguments, the research questions for this study were as follows:

RQ1 *What are the conceptual foundations of the business intelligence frameworks currently used in the South African Public Higher Education Institutions?*

RQ2 *Are these Business Intelligence technological entities theoretically and practically contextualised?*

The above research questions came from the broader research aim of trying to get information about the business intelligence solutions and frameworks currently used in the South African higher education sector. The question required the researcher to classify the scientific knowledge relating to current business intelligence applications and contextualize them in relation to theories and practices of IS research. After scanning and contextualizing the BI frameworks currently used as basis for management information systems in the South African public higher education sector, this researcher came up with a customised business intelligence for the sector. In this study, this researcher assumed that there is a hybrid of business intelligence applications and solutions within the sector and in some cases, there might be no BI solutions at all. The business intelligence framework developed was called

a Context-aware Business Intelligence Framework (CABIF). In order to develop CABIF, the study was guided by the following research question:

RQ3 *What Context-aware business intelligence framework is suitable for the South African Public Higher Education sector, and why?*

This research question suggests deriving the common entities within the higher education sector in South Africa. Grounded on the theoretical underpinnings behind business intelligence systems, context-aware and information systems, the research question intends to unravel the theoretical, practical and methodological foundation of BI systems in higher education. In pursuit of answering this question the study included, clustering, cataloguing and documenting BI observable and measurable variables. This was complemented by using design science research to draw up relevant knowledge from the South African higher education sector, including their statutory obligations. The data collected during the process of answering the first research question provided insights on how a context-aware business intelligence framework for the sector could be developed. To put into practice the CABIF, the study tried to answer the following additional research question:

RQ4 *How can CABIF be rolled-out as a vehicle for decision making processes at the Univen?*

RQ5 *What technology can the Context-Aware business intelligence framework (CABIF) be implemented as a vehicle for decision making processes at the Univen?*

The CABIF in SA higher education is a theoretical and practical approach to sensitize HEIs in streamlining their data assets, from various peripheral systems for managers to access accurate, timely and meaningful information, when making key decisions regarding core institutional processes. The institutional strategic planning within SA higher education needs to respond to the inherent changes that are constantly changing, whether legislative, or those found from environmental scanning initiatives. This researcher is of the opinion that, this BI artefact for the SA higher education can be used by the various institutions as a way of extrapolating the levels of their institutional intelligence initiatives.

The researcher suggests that a BI solution with hierarchical reporting with an addition of enrichment variables for the ITS administrative information system at Univen. The implementation of the BI solution based on CABIF, would not mean that all the outcomes of the research would have been achieved. Therefore, this researcher implemented a CABIF

based BI solution at the University of Venda addressing the following sub-research questions:

- a. How is the existing technology infrastructure leveraged to accommodate a university-wide business intelligence based management information system?*
- b. What information presentation formats constitutes reports that facilitate decision making processes within the institution?*
- c. How do various managers monitor the contribution of their entities through the implemented business intelligence solution?*
- d. To what extent do users build their own web-based multi-dimensional reports using the developed solution?*
- e. What indicators allow academic entities to compare their performances in different functional areas?*
- f. How can a business intelligence system be incorporated as a strategic performance management tool within the institution?*
- g. How useful is the business intelligence application in providing a forecast of the block grants from the Department of Higher Education and Training?*
- h. What is the end-users' perceived adoption and acceptance of the implemented business intelligence solution?*

1.9 Theoretical Lens Used to Understand the Research Space

This researcher agrees to the fact that the mixed methods research design employed, has a number of implications for the scope of the study and the overall contribution of the research to the IS and management field. The critical realist philosophical approach that this researcher chose, also orientates the values and beliefs that underpin this research and provides a lens that guided this researcher during the study. The mixed methods approach influenced on how this research was structured and positioned in the wider research space, as this researcher conceptualized how to strike an equilibrium between quantitative, qualitative and design science research paradigms. The mixed methods research approach assisted this researcher in determining the practicalities of the research, particularly the, “who, why, what, where, when and how” components of the study. The key premise in a mixed method research is the complementarity that is allowed by using multiple methods in the same research enquiry. Mixed methods allowed the researcher to take up the challenge of integrating competing knowledge from the different research world views and contesting the binaristic thinking that has flooded the research of BI.

The adoption of a critical realist philosophical approach in this research impacted upon what was featured, highlighted, silenced and marginalised in the study. This researcher found out that using the traditional or conventional research methodology employed in most BI research has led to technocentric and simplistic approaches to the research, which in this researcher's view could be very limiting. The critical realist approach allowed this researcher to critically lens through the BI domain within the South African HEIs, and distinguish the vacuum in managing by fact, laborious statutory reporting requirements, and the integration of various institutional data assets for effective decision-making. The lack of a contextualised BI approach has therefore negative impacts on the institutional governance, government compliance, accountability, institutional performance assessment among others. The critical realist epistemological approach allowed this researcher to value core institutional business processes as key drivers for effective BI systems.

1.20 Structure of the Thesis

Chapter 1 states the general field of the research which is business intelligence in South African higher education. The Chapter alludes to the background of the research problem, and clearly outlines the research setting and the purpose of the study. The exact knowledge gap in business intelligence research in the South African higher education sector is presented. The chapter presents the primary and secondary research questions which guided the study and the hypotheses which were elaborated for the technology acceptance at the University of Venda. The scope of the research and its significance is also outlined in Chapter 1.

Chapter 2 gives a chronological history of BI and also looks at the BI frameworks that have been used in various business domains. A critique of six different business intelligence maturity models is described in this chapter, and a further two models from the higher education sector. In this chapter business intelligence systems in higher education are elaborated in such a way that the needs, challenges and various business intelligence used in the sector are clearly revealed. The chapter winds up by stating the reasons why the business intelligence frameworks found in literature are not completely suitable for the South African higher education. The need for a context-aware business intelligence system for the South African higher education sector is then corroborated.

Chapter 3 presents the philosophical tradition supporting this research, as well as to present the research strategy and the empirical research techniques applied. The chapter describes the mixed methods research design approach and evidently stating how this research design approach was used in the study. The chapter also covers issues related to how data was collected and measured to respond to each of the research questions. The population and sample, the sampling design, sampling techniques and the sample selection criteria used is also documented in this chapter. Chapter 3 winds up by presenting the data collection methods, data capturing and editing, and data analysis approaches that were used in the study.

Chapter 4 presents the data analysis of the data collected during the fieldwork, followed by the presentation and discussions of the research results. The first part of Chapter 4 shows how the data collected from 47 respondents during the pilot phase assisted in refining the business intelligence survey which was administered within the South African higher education sector. The second part shows how the principal components analysis (PCA), assisted this researcher to identify and extract important business intelligent factors, which this researcher used design science research techniques in the development of the context-aware business intelligence framework.

Chapter 5 presents how the design science artefact, in this case the CABIF was unpacked and developed. This chapter unpacks the symbiotic relationship of the different strands of the mixed research methods, and the design science research approach. The chapter clearly explains the first four strands of design science research, leaving the last two steps to be implemented in chapter 6.

Chapter 6 presents how this researcher seeks to validate the conceptualization and practical implementation of the context-aware business intelligence framework at the University of Venda. This chapter presents how this researcher took a conscious approach of implementing CABIF at the University of Venda by modelling the various BI contexts in the CABIF. The justification of why this researcher chose the PowerHEDA reporting framework as the front-end and the Microsoft Business Intelligence suite as the backend of the BI platform, is also presented and articulated in Chapter 5.

Chapter 7 details the major findings of this research, and cite the implications of these findings to information systems research and the broader academic community. The chapter

also presents the problems that this researcher faced during the research and the limitations of this research thereof. The future research roadmap of this study, is also alluded to in this chapter. The chapter winds up by outlining some recommendations and this researcher also gives some autobiographical reflections regarding the study.

1.21 Suggestions on Reading this Thesis

There are some issues that need to be clarified when reading this thesis. The double quotation marks in this thesis in most cases show the bibliographic extracts, which include references to the author and the page numbers where the text was extracted. In some instances, these are shown in italics and in double quotes. The italics without any form of quotes, are an indication of some form of emphasis the researcher wants to indicate, and in some instances, indicating some extracts from the responses to the survey that was deployed within the SAHEIs. The referencing in this thesis adheres to APA 6th referencing style, which is one of the most popular referencing styles.

The research methodology spans from Chapter 3 to Chapter 6, which is in contrast with other doctoral theses that have it in one chapter. This researcher, spans the research methodology in four chapters as a means of showing the sequential mixed methods research that was followed during the study, and dedicated a chapter on '*Data Analysis Results Presentation and Discussions*', another on the designing of CABIF and a chapter on deploying and evaluation of the BI system based on the Context-Aware Business Intelligence Framework. The reader might be tempted to see the six steps of design science research in one chapter, in this case Chapter 5. The researcher intentionally put the evaluation of the developed artefact (CABIF) in Chapter 6, as a means of linking it with the implementation in the same chapter.

The terms '*this researcher*' and '*the researcher*', in the context of this thesis are referring to the author of this report, who happens to be the doctoral candidate. It is also important to note that, all the captions of the tables and figures are below each figure or table. In some theses reports, the captions of the tables are above the tables and the captions of the figures are below the figures. It is also important to note that in some theses, the penultimate section of each chapter is a summary to the chapter and the last part of each chapter is the conclusion section. In this thesis, the researcher has resorted to end a chapter with a summary, which in most cases include the important conclusions drawn up by the researcher.

1. 22 Summary to Background and Introduction

In this Chapter, this researcher has demonstrated that the post-apartheid higher education system in South Africa has witnessed significant legislative and policy changes. Some of the most important documents that address these significant policy changes include, the White Paper 3: A programme for the Transformation of Higher Education (DoE, 1997); National Plan for Higher Education (DoE, 2001); National Development Plan (Manuel & Ramaphosa, 2011); White Paper for Post-School Education and Training: Building an Expanded, Effective and Integrated Post-School System (DHET, 2013), and other policy documents that defined the governance of higher education institutions (Presidency, 1997). These policy documents emphasized and reviewed on how institutions shift from apartheid and minority rule practices, to the democratic dispensations advocated for by the new majority government. HEIs have to rethink their visions, missions and their values to fit the new terms of reference accommodated by the new democratic principles.

The Government Gazette No. 37726, published on 9 June 2014 set the tone for new '*Regulations for Reporting by Public Higher Education Institutions*' in South Africa. The emphasis of the new reporting regulations is for SAHEIs to establish clear relationships between institutional planning, budgeting and reporting to the DHET. This researcher established the lack of contextualised business intelligence processes that can be used as vehicles for decision-making within the institutions. This researcher also established the need for an empirical and theoretical situated approach in establishing BI systems with the SAHEIs. The laborious new reporting requirements established by the DHET requires institutions to have BI systems that provides reporting information promptly. The reporting cycle apart from being all year around included different types of reports with varied data types. In this chapter this researcher elaborated on the basic tenets of this study which are deriving at the individualised and contextualised BI system for each institution. This is achieved by CABIF, which is a situated BI framework for the South African higher education institutions.

In the next chapter, the researcher expounds on the concept of business intelligence, by looking at origins and developments including the associated theories behind business intelligence systems. As there are many business intelligence maturity models, and strategies developed over the years, the reader will get an insight of what the researcher

thinks are the theoretical and methodological gaps in implementing BI systems within the higher education landscape.

Chapter 2 : Literature Review

This chapter gives a chronological history of business intelligence and also looks at the business intelligence frameworks that have been used in various business domains. A critique of six different business intelligence maturity models is described in this chapter, and a further two models from the higher education sector. In this chapter business intelligence systems in higher education are elaborated in such a way that the needs, challenges and various business intelligence systems used in the sector are clearly revealed. The chapter winds up by stating the reasons why the business intelligence frameworks found in literature are not completely suitable for the South African higher education. The need for a context-aware business intelligence system for the South African higher education sector is then corroborated.

2.1 Origins of Business Intelligence

Business Intelligence, is a phrase that was coined in 1865 by Richard Millar Devens in his book “Cyclopaedia of Commercial and Business Anecdotes,” is in modest expressions an approach to look at the larger scope. Richard Millar Devens’ used the term business intelligence to describe the way that a banker, Sir Henry Furnese, succeeded in banking, as he understood political issues, instabilities, and the market well ahead of his competitors. Devens wrote that Furnese was well known throughout Holland, Flanders, France, and Germany, because of maintaining a complete and perfect train of business intelligence. In the 19th century, Devens has envisioned the idea of gathering information on business conditions, as a seed that would grow the business venture in the banking sector. Before the 20th century technology did not develop to the extent which it could be measured as a proxy of business intelligence (Negash & Gray, 2008). It was with the 1958 publication of a landmark article on the subject, written by IBM computer scientist Hans Peter Luhn, that the potential of BI was recognized (Luhn, 1958).

Hans Peter Luhn’s article, entitled “*A Business Intelligence System*”, described a business intelligence system as “an automatic system developed to disseminate information to the various sections of any industrial, scientific, or government organization.” In the wake of the post-World War II, the industrial, scientific or government sectors, required a way to organize and simplify the rapidly growing mass of technological and scientific data. Luhn (1958) defined the term business intelligence by decomposing the elements of this compound word. Business was defined as “a collection of activities carried on for whatever purpose, be it

science, technology, commerce, industry, law, government defence etc.” Intelligence was defined in a more general sense, as “the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal”. Luhn (1958) then coined the term business intelligence system by indicating that these involve a communication facility serving the conduct of the business in a broader sense. Having given a brief background of BI, Table 2.1 looks at some of the definitions of BI this researcher has found from literature.

	Definition	Reference
1	BI is an umbrella term that includes the applications, infrastructure and tools, and best practices that enable <u>access to</u> and <u>analysis</u> of information to <i>improve and optimize decisions and performance</i> .	Gartner
2	BI is the use of computing technologies for the <u>identification</u> , <u>discovery</u> and <u>analysis</u> of business data - like sales revenue, products, costs and incomes.	Technopedia.com
3	BI simplifies information <u>discovery and analysis</u> , making it possible for <i>decision-makers</i> at all levels of an organization to more easily access, understand, <u>analyse</u> , collaborate, and act on information, anytime and anywhere	Microsoft
4	BI is evidence-based <i>decision-making</i> and the processes that <u>gather</u> , <u>present</u> , and use that evidence base	JISC
5	Computer-based techniques used in <u>spotting</u> , <u>digging-out</u> , and <u>analysing</u> 'hard' business data, such as sales revenue by products or departments or associated costs and incomes	BusinesDirectory
6	Business Intelligence entails the <u>gathering of data</u> from internal and external data sources, as well as <u>the storing and analysis thereof to make it measurable</u> , so as to assist and sustain more efficient and <i>longitudinal decision-making</i>	Van Dyk Geiger, Rahman, & Barth (2008)
7	BI deals with <u>integrated approaches to management support</u> and is defined as “a set of <u>methodologies, processes, architectures, and technologies</u> that <u>transform raw data into meaningful and useful information</u> used to enable more <i>effective strategic, tactical, and operational insights and decision-making</i> ”	Muriithi & Kotzé Anagnostopoulos & Hadjiefthymiades (2013)
8	Business intelligence is more than a collection of tools and techniques. It is a <u>multi-dimensional</u> concept concerned with the <u>effective deployment of organizational practices, processes, and technology</u> to create a <u>knowledge base that supports the organization</u>	Dawson & Van Belle Anagnostopoulos & Hadjiefthymiades (2013)

Table 2.1 Some Definitions of Business Intelligence

Sharman (2010), defines BI as the “*skills, processes, technologies, applications and practices used to leverage an institution’s internal and external information assets to support and improve decision making*” (p.1). The fact that business intelligence helps managers to make “*better business decisions*” (Lock, 2011; Piedade & Santos, 2010; Sharman, 2010), is evident as several studies advocate business intelligence practices within organizations. Business intelligence solutions in Higher Education have gained momentum and according

to Guster & Brown (2012) and the IBM solution brief (2011), a “*third of the United Kingdom’s Higher Education institutions use the IBM Cognos Solutions*”. IBM Cognos is a web-based, integrated business intelligence suite by IBM, which provides a toolset for reporting, analysis, score carding, and monitoring of events and metrics. Business intelligence solutions give managers the visibility, insight and to take proactive actions in areas where their organizations should improve in performance (Lock, 2011). The attainment of such a goal in Higher Education requires business intelligence practitioners to specify a business intelligence framework that aligns with the business strategy of the institutions, their visions and missions, and to study the cultural and organizational behaviour of the institutions.

Henry and Hiltbrand (2012) argue that the workplace is changing tremendously and will continue to change as the decade wears away approaching 2020. BI has reached a maturity level that affects the workplaces because of the myriad of technological tools found in it, and only organizations with mature BI practices will survive the hype (Henry & Hiltbrand, 2012). The consumer and product industries have a mature BI environment compared to the research and academic environments, due to available sponsorship, effective governance, a solid BI infrastructure and a strong BI staff (Barnes et al., 2012). The Higher Education landscape is no exception to Business Intelligence initiatives, with Infobuilder, IBM Cognos, Microsoft Business Intelligence and SAP Business Objects being among the tools used (Guster and Brown, 2012; IBM, 2010). In South Africa, the uptake of BI solutions in Higher Education is not as documented or is not as sophisticated as is in the developed world.

Luhn’s efforts in coining the BI concept have additional methodological strides than just presenting and developing the prospects of a concept. His investigations established approaches that were constructed upon to craft some of IBM’s yardstick analytical systems. Luhn’s research work on analytical systems at IBM made him dubbed the “Father of Business Intelligence” in academic circles. In other historical presentations of the origins of BI, it is said that, it originated from decision support systems, which first materialized in the early 1970s when managers used computer applications to project business decisions (Wixom, Watson, & Werner, 2011). For this research, BI are skills, processes, technologies, applications and practices used to leverage an institution’s internal and external data assets to support and improve on its decision-making. This researcher has defined and scanned the origins of BI and subsequently gave an operational definition of BI for the purposes of this research. However, this researcher needs to enlance the historical developments of BI, until the current moments in history.

2.1.1 Business Intelligence Advancements in Late 20th Century

With the introduction of computers in the commercial world, firms lastly had different ways of storing data apart from paper. IBM's creation of the hard disk in 1956 transformed data storage mechanisms. Data storage technologies bred the foundation of the first database management systems, collectively referred to as decision support systems (DSS) (Briggs, 2014). According to Weiss (2012), by the 1970's a few BI vendors popped up with tools that made accessing and organizing this vast amounts of business data possible. In the 1970s and 1980s, a series of technologies have been integrated into one set of technology, contributing to the development of business intelligence, and these include DSS, Executive Information Systems (EIS), Data warehouse, Online Analytical processing (OLAP), predictive analytics, extraction, loading and transformation (ETL) and Data Mining (Foody, 2009; Hiltbrand, 2010; Russom, 2012).

BI technologies have been proliferating in a haphazard way in the 1970s and early 1980s (Negash & Gray, 2008). The mushrooming of BI developments led to a 1988 international conference aimed to rationalize data practices (Kroonenberg, 2008, p. 702). The Multiway Data Analysis consortium, held in Rome, was a leap forward in the rationalisation of BI investigations. The contemporary phase of business intelligence began instantly after the 1988 conference. In 1989, Howard Dresner, a Gartner analyst once more conveyed the expression "business intelligence" into the mutual language (O'Leary, 2009). Dresner engaged the "business intelligence phrase" as a universal term to cover the burdensome sounding names for data storage and data analysis, names like decision support systems and executive information systems (O'Leary, 2009; Watson & Leonard, 2011)

2.1.1.1 Critical Business Intelligence Turning Points in the 1980's and 1990's

The Multiway Data Analysis consortium, held in Rome, sparked the rivalry from BI vendors, which ultimately led to developments in data architectures, which included data warehouses (Russom, 2010, 2012; Sandler, 2010). As Lewis (2013) argued that, data warehouses enhanced the movement of data as it moved from operational systems to decision support. Data warehousing significantly expurgated the time it took to access data (McKenna, 2011). Data warehousing managed to break disparate data storage islands. This was achieved because the data that customarily had been stored in various storage spaces was now all in a single location (Azmaa & Mostafapourb, 2012; Bahrami, Arabzad, & Ghorbani, 2012).

The developments in data warehousing, along with complementary facades of data warehousing brought forth technologies and tools that are staples of BI today (Eckerson, 2004; Jennings & Lewis, 2011; Sen & Sinha, 2005). These complementary technologies included Extract, Transform, and Load (ETL) tools and OLAP software (Gonzales, 2011). In the later years, this BI phase of development became known as business intelligence 1.0. This first generation BI focused on approaches, technology, and preeminent practices of using data to initiate decisions and comprehend the business.

2.1.1.2 First Generation Business Intelligence

As business intelligence became a commonly known phrase in the late 1990's and early 2000's, dozens of new vendors hit the market. During this period, the basic functions of BI were producing data and reports; organizing it; and visualizing it in a presentable way. Yet there remained two significant issues holding back this developing phase of the technology, which were complexity, and time. Too many projects were owned by the IT department, meaning that most users were still not capable of executing BI tasks on their own. Existing BI tools had not been developed with anyone but experts in mind, and extensive analytics training was required to gain insights. And because data was existing as siloes, it took more time to formulate and deliver reports to decision makers. Only technical experts were able to utilize advanced data analysis software.

As time went by, tools began to evolve to cater for non-technical users, but it happened slowly. The reports that were coming out of the BI 1.0 systems provided historical, current, and predictive perspectives. It was achieved through a combination of operational and strategic views (Foody, 2009; Geiger et al., 2008; Imhoff & White, 2010). Although the first generation achieved substantially, it was still left with a lot to be desired. The ownership of BI was still belonging to the IT department, so business users didn't have the control or access needed to make effective decisions. The systems for this generation were generally slow to respond, very inflexible and not very interactive (Rajterič, 2010).

2.1.1.3 Second Generation Business Intelligence Technologies

The genesis of the 21st century discern a recognizably different turning point, as technologies were established to discourse issues of both convolution and speediness (Guillemette & Paré, 2012; Guster & Brown, 2012). The second generation BI Technologies (BI 2.0) included a multitude of diverse technologies such as real-time processing, which

integrated information from events as they happened into data warehouses, permitting business organizations to make decisions based on the most recent information available (Anagnostopoulos & Hadjiefthymiades, 2010; Briggs, 2012). BI 2.0 technologies were also augmented by the commencement of cloud-based applications that stretched and abridged the extent of BI platforms (Briggs, 2014; Burke & Hiltbrand, 2011). In a nutshell, BI 2.0 technologies were simple to use, pervasive, collaborative, and engaging BI. The lines of business were owning the data, and BI was integrated with business goals and ideals.

2.1.1.3.1 Business Intelligence and the Proliferation of Internet Technologies

The exponential growth of the Internet supported and advanced further the BI technology developments, in part through the genesis of social networking tools (Hiltbrand, 2010; Imhoff & White, 2010). Facebook, Twitter, and blogs gave users very simple and very quick ways of sharing ideas and opinions (Polites & Watson, 2009; Shankar, 2011). Social networks also provided a way for users to review methods and software, and more broadly publicize a rudimentary understanding of the diverse practices of business intelligence. The more that people communicated, the more that they understood BI practices and usage. By 2005, the snowballing interconnectivity of the business world meant that organizations required real-time information, for a variety of motives (Rutstein, 2011).

Business organizations were now using BI to primarily keep up-to-date with the competition in the market, and comprehend what their consumers wanted and what they thought of their organizations (Scott, 2011). BI was no longer an added utility, or a mere advantage. It was becoming a requirement for businesses looking to stay competitive, and even to remain afloat, in an entirely new, data-driven environment. The trend today is to address these issues by increasing the capabilities of a BI solution, bringing discoverability, collaboration, self-service, insights, and data access together (Briggs, 2014). The BI technologies were doing these services through browser based, interactive, and real-time, hence empowering users to make right decisions. Other technologies that came into play included self-service access for non-expert users, meaning that employees could now complete projects without interference from the IT department.

2.1.1.4 Self-Service Business Intelligence

The suppleness and speed of the mid-2000s business intelligence platforms have undergone a strong refining process. The empowerment of BI end-users into the modern day is something the naysayers are echoing. The expansion self-service BI options, and improving visualization are three of the most significant qualities of the current wave of BI advancements (Watson, 2012a, 2012b; Young, 2012). According to Waheed (2011), the BI technologies being developed presently are often intended for a very explicit business, be it healthcare, law enforcement, education or even professional sports. This software verticalization, which defines the growth of industry-specific tools has backed ominously the amplified acceptance of business intelligence (Watson & Leornard, 2011). The BI self-service tools and visualization structures depend on one another for their evolution. The big data panacea and the burst of the Internet left organizations with more data than before (Xuea, Pung, & Sen, 2013).

Currently each person or a business unit in an organization is increasingly creating large amounts of information. The huge amounts of data disposable, require organizations to have even more visualization tools. The visualisation tools coupled with predictive analytics tools within the BI environment, would make companies to actionably make sense of their data assets (Akbay, Fryman, Stodder, & Taylor, 2011; Bahrami et al., 2012). The visualization tools, formally known as infographics, began to advance to embrace the end-user substantially. More BI platforms permitted users to complete self-service access, meaning that they could discover and exploit their data on their own, devoid of being trained on the systems (Ayyagari, Grover, & Purvis, 2011). In the advent of mobility, big data and analytics, social business and the cloud, the third generation information technology platforms are shaping BI developments. Briggs (2014) also confirmed that BI users are now able to access technology more easily because of cloud computing. One question that one will be prompted to ask is, "What is the position of BI technologies in the hype of cloud, mobility, and big data?" In the next section an exploration of BI technologies within this new wave of technology hype is carried out.

2.1.1.5 Cloud Business Intelligence and Mobile Business Intelligence

The current growth in BI technologies is fuelled by exciting technology advances in the areas of social computing, unstructured data analytics, mobile delivery, and big data (Azmaa & Mostafapourb, 2012; Bahrami et al., 2012; Briggs, 2014) . These technologies involve

datasets that propagate so enormously to the extent that they become obstinate to work with using orthodox database management tools. More technology companies have begun and are currently offering these BI capabilities, which involved Hadoop, NoSQL and unstructured data sources. Hadoop is a free java-based programming framework in a distributed computing architecture which supports large data processing. NoSQL is a non-relational database technology that offers apparatus for storage and retrieval of data that is modelled using other means than tabular or relational calculus. The technology companies began to offer unique, cutting-edge BI technology attributes as the only way to stay ahead of the competitive curve compared to other vendors (Acebo, Franks, Leonard, Manthey, & Burgess, 2012; Briggs, 2014). Cloud BI, basically entails providing business intelligence by having the BI systems hosted on the Internet, reducing storage costs and making access to organizational data and insights faster and more convenient for non-technical users (Briggs, 2014; Chen, Chiang, & Storey, 2012; Chen & Hu, 2013).

The third-generation information technology platforms were tangential to the cloud as the rise of mobile-empowered platforms, allowed users to work with BI anywhere, anytime on smartphones, tablets, and other mobile devices (Briggs, 2014; Dresner, 2011; Ehrenmann, Pieringer, & Stockinger, 2012). As the BI tools are perfected and improved, they are also being made simpler and more convenient, encouraging wider use acceptance and adoption (Chen & Hu, 2013; Decouchant, Mendoza, Sánchez, & Rodríguez, 2013; Devlin, 2012). This BI era included, creating data governance and stewardship responsibilities and frameworks in concert with business owners and security. Another related BI technology move was to feed analytics with a data architecture that integrates existing, new and big data within a consistent framework (Briggs, 2014; Cantin, 2011; Chen et al., 2012). The BI technology gurus advocated for the provision of traceability from data sources to usage and rigorously assessment of the value of data sources (Acebo et al., 2012; Briggs, 2011, 2012).

The history of business intelligence acknowledged the fact that applications required a warehouse of data, some of which was obtained from operational systems, but also other data, such as external data (Chen et al., 2012; Couture, 2012; Gonzales, 2011). In most data warehouse implementations, the data architectures were personalized for the precise DSS that was established. As Acebo et al. (2012) argued, it can be concluded that the process of developing a data warehouse was an application-centric approach, with the data supporting a single or a few related business processes. The BI technology developments have seen an evolution of analytic and visual tools, with a diverse host of technologies.

These analytic tools supported various vendor DBMS offerings using a common structured query language.

Most of the data were being able to be exported into spreadsheets like excel, and were becoming more of open standards (Ehrenmann et al., 2012; Falamasir et al., 2010; Fehlberg, Rolim, Leithardt, Geyer, & Silva, 2013). The skills in SQL and other relational technologies were being portable from one BI system to the other. These developments allowed for the establishment of a common ground to evaluate data architectures, BI technologies and the associated technologies. This movement allowed for the setting up of benchmarks and standards that permit for the comparison of BI technologies. BI frameworks, maturity models and standards were established as an intelligent means of comparing various BI wares.

The historical overview of BI systems has a direct impact on reviewing the methodologies, and technologies used to implement BI systems. The historical overview shows how other industries which are not education related adopted BI for their organisational intelligence endeavours. This prompts the researcher to look further into the theoretical frameworks used to design, develop and implement BI systems, and reflect on their suitability for the higher education sector.

2.2 An Overview of Business Intelligence Frameworks

Many organizations have a heterogeneous assortment of server technologies, distributed systems, several databases, and different personal computing equipment. Delivering BI capabilities and processing data is usually fragmented across these hybrid systems. Data duplication is no exception under such circumstances, and delivering the data in the format required by the users is usually a nightmare. The data warehouse panacea has been purported as a replacement of these hybrid systems, and in actual fact has yielded considerable amount of success (Fenn, 2007; Geiger et al., 2008; Gonzales, 2011; Handoyoa, Isnanto, & Sonda, 2012). The data warehouse is much more than a reorganization of the data assets. It is a much cleaner version of the data assets existing in the disparate organizational databases. However, the data warehouse does not provide all the solutions towards the meaningful analyses needed in business.

The all-inclusive gamut of data-related functions within an organization has become a set of standards and expected processes that complement the data warehousing initiatives. BI

professionals are now following and citing steps to implement a BI system by rote (Javadi & Dastjerdia, 2011; Lahl, 2011; Lewis, 2013). The BI maturity models have been purported to offer the adequate benchmarks for comparison, evaluation and justification of BI investments within organizations (Rajterič, 2010; Scott, 2011; Shankar & Menon, 2010). Maturity models define levels of definition, efficiency, manageability and measurement of BI systems in a controlled environment (Rajterič, 2010). Maturity models are used to expound, elucidate, and assess the evolution of the life cycles of business intelligence systems (Halper & Stodder, 2015; O'Leary, 2009; Rajterič, 2010). The simple notion behind maturity models is that things alter with time and that most of the variations can be foretold and controlled (Halper & Stodder, 2015). The models in BI systems evolve gradually, and these same models can be improved based on past experiences (Rajterič, 2010). The Capability Maturity Model (CMM), developed through the Maturity Thesis by Humphrey in 1989, within the software development environment is the premise for all maturity models Rajterič (2010, p. 49).

2.2.1 Business Intelligence Maturity Models

Each of the BI maturity models consists of a model and a questionnaire, which is used to evaluate the levels of maturity of the development environment (Halper & Stodder, 2015). Key processes, which represents phases to be completed by the organization, are typical inside each level of maturity are defined. Skipping the maturity levels is not possible, as each level of maturity has fundamental attributes to be benchmarked. The levels of maturity differ depending on the different maturity models and the problem domain (Halper & Stodder, 2015; Rajterič, 2010; Watson, 2012b). Although BI brings a lot of potential benefits, the effective use of business intelligence has proved to be quite a challenge in most organizations (Halper & Stodder, 2015; Rajterič, 2010; Watson, 2012b). Organizations are faced with challenges of leveraging BI investments and to move to the next level of BI maturity. Maturity models for BI have proved to be important in this process as they describe the paths for line of business and IT alignment. The maturity models for BI help organizations to understand where they are and how they can improve their business processes (Fenn, 2007; Halper & Stodder, 2015; O'Leary, 2009; Rajterič, 2010).

One question that this researcher may be forced to ask is, *“Which are the BI Models, frameworks that have been used, and that are popular from literature? Are these frameworks relevant in all types of organizational domains including the higher education sector?”* The

preliminary response to these questions are that, all BI tools are not alike just like the BI frameworks as well, and even similar BI tools have their quirks. As there are an amalgam of business enterprises so are the BI frameworks that are suitable for these enterprises. Before this researcher can confirm or refute this proposition, this researcher looks at the BI models/frameworks as found in the literature. The following section shows the most popular business intelligence maturity models this researcher found in the literature.

2.2.1.1 The Data Warehouse Institute (TDWI)'s Business Intelligence Maturity Model

Eckerson (2004) originally developed, theorised and publicised the TDWI's Business Intelligence Maturity Model. The focus of this model was on the technical aspects of the BI maturity assessment (Rajterič, 2010, p. 51). The eight key areas that the BI Maturity is evaluated using this model are: Scope, Sponsorship, Funding, Value, Architecture, Data, Development and Delivery (Halper & Stodder, 2015). Each of the eight key areas are graded on the same five grade scale: Infant, Child, Teenager, Adult and Sage (Eckerson, 2012). The main characteristics of the grading levels of the TDWI's Business Intelligence Maturity Model as defined by Eckerson (2012) are:

a) Infant

The level is composed of two phases, which are the Prenatal and Infant (Eckerson, 2012; Halper & Stodder, 2015). Standard sets of static reports embedded in an operational reporting system is typical of the Prenatal phase (Rajterič, 2010). These reports are usually built and limited to an operational system. The major setback for this phase is on adjusting and delivering of customised reports. Users are usually forced to create parallel data sources because of lack of agility of BI systems within this phase (Halper & Stodder, 2015; Rajterič, 2010). The Prenatal phase only ends when a data warehouse is built. Numerous partial data sources Spreadmarts on the other hand, are typical of the Infant phase. Spreadmarts are spreadsheets or desktop databases which are used as a replacement for regional data warehouses (Eckerson, 2004; Rajterič, 2010). According to Rajterič (2010), each of the Spreadmart contains a set of specific data, metrics, rules, operational reports or analytical systems with no or limited correlation. The existence of fragmented data sources in the Infant phase result into conflicting views on valuable business information. The resultant factor is that the effective decision-making processes supported by the strategic goals are usurped by inconsistent data formats within the organization.

b) Child

This stage is characterised by knowledge workers teaming up with the community of BI users. The information demands are gathered at departmental to cater for the data needs of only that department (Rajterič, 2010). Knowledge workers usually analyse trends on the data by using Of-the-Shelf interactive reporting tools to drill the data. The main focus and importance of the BI tools found on this phase are to understand the correlations in the data and comprehending historical business actions. The data dictionary is limited to a regional data warehouse and is retrieved directly from the operations information systems (Eckerson, 2012; Halper & Stodder, 2015; Rajterič, 2010). The major bottleneck of BI systems at the Child maturity level are that they don't accommodate interdepartmental consolidation and data analysis.

c) Teenager

As organizations start to recognize the need to accommodate interdepartmental consolidation and data analysis, standardized set of project and BI development methodologies emerge. The organization start to include best practices, learning on past experiences and start to use external BI consultants extensively (Eckerson, 2012; Halper & Stodder, 2015; Rajterič, 2010). A structured approach to BI development and management under the leadership of BI program manager emerge at the Teenager phase. In the different organizational departments, a crop of BI champions emerges, and these are jointly responsible for developing a common data model and BI technology platform (Eckerson, 2012; Halper & Stodder, 2015; Rajterič, 2010). A central data warehouse that accommodates interdepartmental consolidation and data analysis is developed. The central data warehouse facilitates organization-wide data analysis, bridging the borders of individual departments by gaining new knowledge. Among key BI tools within the Teenager BI maturity phase are customised dashboards which include key performance indicators. As Halper & Stodder (2015) puts it, the BI usage is spread among regular users and it enables the knowledge workers to interactive reporting and analysis.

d) Adult

The Adult BI Maturity phase is characterised by BI tools developing from tactical to strategic business level. The daily operations of the line of business are driven by the central IT system, and these are monitored by a system of dashboards. Business performance and

key performance indicators are aligned to afford the comparison of the actual state with the strategic objectives set by the organization (Halper & Stodder, 2015). The Adult phase of BI maturity is composed of centralized BI data sources, fully loaded flexible and common data warehouse, and centralized BI management reporting to the executive management (Halper & Stodder, 2015; Rajterič, 2010). The language and the metric rules are unified across the organization with the BI system housing all the data assets of the organization. The Adult phase sees companies starting to use predictive and modelling tools within their BI environments. The fully loaded data warehouse coupled with predictive analytics tools allow organizations to adjust to new business needs (Halper & Stodder, 2015; Rajterič, 2010).

e) Sage

The organizations that have BI systems at the Sage maturity phase turn the BI systems into technical and business services affordances. The development is moving back into the organizational functional units through Centres of Excellence (Halper & Stodder, 2015; Rajterič, 2010). Rajterič (2010) stated that the Sage BI maturity level is characterised by distributed BI development, data services and an extended enterprise BI architecture. The data warehouse managed by a central information management team is seen as a repository of institutional information. The service oriented architecture allows for a faster distributed development of BI resources. The usage of BI systems dramatically increase, with business and IT alignment quite evident at this level (Halper & Stodder, 2015; Rajterič, 2010). The BI provides services with high significance, bringing high business value and a competitive advantage to the organization.

2.2.1.2 The Business Information Maturity Model

Increasing the importance of business intelligence is the major focus of the Business Information Maturity Model. The model defines three key success factors of business intelligence which are: alignment and governance, leverage and delivery (Rajterič, 2010). The evaluation of BI using this model covers seven key areas namely BI strategic position, partnership between business units and IT, BI portfolio management, information and analysis usage culture, process of improving business culture, process of establishing decision culture, and technical readiness of BI/DW (Rajterič, 2010; Williams & Thomann, 2003). The obstacle in positioning the business to make better use of data warehousing as Williams & Thomann (2003) argued, has been the abhorrence that organizations have to embrace how BI impacts the way they do business.

The Business Information Maturity Model provides organizations with benchmarks to view BI not just as a technical enhancement of their current information usage, but as a means to change the way they carry out their business. The main characteristics of the Business Information Maturity Model as publicised by Williams & Thomann (2003) are First Level, Second Level and Third Level. The next sections give a brief description of the levels constituted in the Business Information Maturity Model.

a) First Level:

The use of information within the organization follows an unstructured way resembling the same data handling procedures just before the establishment of a data warehouse (Rajterič, 2010). The organizational demands for information focus on what the business users want to access. The access is usually in the form of discrete data elements which generated and passed to the business users by the central IT department (Rajterič, 2010).

b) Second Level

The role of information to support line of business is recognized and this information is usually to leverage the investment in BI technologies. Business users use information not only on what they need, but they start to interrogate the information to seek answers to why certain things happen, and why they need the information (Rajterič, 2010). The BI users approach the information needs within the organization in terms of who, when and where the information fits into the business goals and business processes (Rajterič, 2010, p. 51).

c) Third Level

At this stage, the organization harness all its data assets by trying to find how existing business processes can be improved. The focus is shifted to the use of information in the management of business processes and the introduction or organizational changes (Rajterič, 2010; Williams & Thomann, 2003). The organization recognizes the high added value of information in optimizing business decisions. The replacement of prior business decisions will be based on the insights revealed from the information from BI systems, hence emphasis is put on optimizing the usage of information throughout the organization (Rajterič, 2010).

2.2.1.3 Gartner's Maturity Model for Business Intelligence and Performance Management

The Gartner's Maturity Model for Business Intelligence and Performance Management, stipulates that any Business Intelligence and Performance Management initiative must achieve the level of maturity appropriate for supporting the enterprise's strategic goals (Burton, 2007; Chandler, Hostmann, Rayner, & Herschel, 2011; Rajterič, 2010; Rayner & Schlegel, 2008). The Model recognizes five levels of BI maturity, which are: unaware, tactical, focussed, strategic and pervasive (Chandler et al., 2011; Rajterič, 2010; Rayner & Schlegel, 2008). Rayner & Schlegel (2008) documented the main characteristics of the model, with Burton (2007) giving a primer on the assessment criteria of the model. According to Burton (2007) the maturity assessment of BI and performance projects includes people, processes, metrics and technology as key areas to consider. The maturity levels of the model are described in following sections:

a) Unaware Maturity Level

This maturity level often described in literature as information anarchy is characterised by inconsistent data, incorrect and inconsistent data interpretation, and constant changes (Burton, 2007; Chandler et al., 2011; Rajterič, 2010; Rayner & Schlegel, 2008). The BI systems struggle to meet or fulfil information needs for individual organizational units. The use of spreadsheets is typical within the organizations, while reporting tools are very limited. The organization does not have defined metrics for performance management. The devotion to align performance management and business intelligence is non-existent. There is a serious lack of understanding the value of aligning business intelligence with the overall performance management system of the organization (Chandler et al., 2011; Rajterič, 2010; Rayner & Schlegel, 2008). The organizational information management, funding of BI projects, and the reporting of the information comes from the IT department.

b) Tactical Maturity Level

This maturity level is characterised by organizations starting to appreciate the value of BI. Companies start to pour funds into BI initiatives, but the metrics used mostly coming from the IT departments (Chandler et al., 2011; Rajterič, 2010; Rayner & Schlegel, 2008). Organizational wide BI metrics are non-existent or are inconsistent, as most of the data assets, BI tools and applications exist in silos. The BI systems used at this maturity level are proprietary with individual organizations find it difficult to customize to their needs. The users

usually lack skills to use or take advantage of capabilities the system. According to Chandler et al. (2011), the quality of the information produced from the BI is questionable resulting in management giving low support and inadequate funding.

c) Focused Maturity Level

The organization which is at the Focused BI maturity level reaps its first fruits and benefits of its BI implementations. As Chandler et al. (2011) puts it, the organization at this level of maturity shows signs of BI success, but the implementation is limited to some parts of the organization. The sponsorship of the BI initiatives is now shifted to a business unit, department from senior management responsible for IT (Rajterič, 2010; Rayner & Schlegel, 2008). Although BI projects within this level strengthen individual departments or units, they are not linked to the broader goals of the organizational business goals. Some of the characteristics at this level include inconsistent metrics and goals of individual organizational units. Rajterič (2010) stated that the users are trained on basic data retrieval functions of the BI system. The data exist through stovepipe solutions with no integration at all (Chandler et al., 2011). The closed BI solutions found at this level cover only some parts of the business such as data capturing and reporting. The Business Intelligence Competency Centre (BICC), where experts from business and IT form an integrated is formed at this level. The merge is done in order to fulfil the needs of the users and business (Couture, 2012).

d) Strategic Maturity Level

The organizations at this maturity level comprise of a clear business strategy for BI development. The top management within the organization sponsor the BI initiatives. The companies at this level integrate BI and performance management into their critical business processes (Couture, 2012; Devlin, 2012; Henry & Hiltbrand, 2012). Accord to Chandler et al. (2011) the use of BI and performance management is usually extended to the organization's business partners, suppliers and even customers. The BICC centres are now equipped with enough resources to achieve the BI goals at this level. The strategic plan, with financial targets are established for the different organizational structure layers. Among other enhancement within this level, data management policy and data quality metrics are in place (Burton, 2007; Chandler et al., 2011). Rajterič (2010) argued that, the resultant effect of having BICC, data management policy and data quality metrics is that the data from BI systems become more trustworthy. The users are also adequately equipped with data processing skills and to use the data for strategic and tactical decisions.

e) Pervasive Maturity Level

At this maturity level, BI and performance management is pervasive across all the business units within the organization and into all critical business processes (Couture, 2012; Devlin, 2012; Henry & Hiltbrand, 2012). BI and performance management are integrated into the business processes, and the BI systems are flexible to adapt to fast business changes and information demands (Rajterič, 2010; Rayner & Schlegel, 2008). The BICC is also proactive, dynamic and produce information that is trusted throughout the organization. The users at this level have the skills to support the data quality and data management policies. Key business performance indicators which are measurable and linked to specific business goals are evident at this level (Tront & Hoffman, 2011; Wagner & Weitzel, 2012; Watson, 2011). The access to business information and analysis by the users is structured in such a way that they add business and enhance the business performance. The business intelligence usage at this maturity level is available to suppliers, customers and business partners (Rajterič, 2010; Smith, Watson, & Sullivan, 2012; Stoodley, 2012).

Gartner uses this Model for evaluating general business maturity and the maturity of the individual organizational business units. The results obtained using the Gartner model has shown that organizations have their business units at different maturity levels (Lock, 2011; Luftman & Derksen, 2012; Rajterič, 2010; Rayner & Schlegel, 2008). What the model is capable of is to identify bottlenecks in the rolling-out of BI in the different business units. The model also allows room for discussion on issues related to BI and performance management between these units. In the process of having the dialogue the maturity levels of each department can be improved. These will then be cascaded up to improve the maturity levels of the whole organization (Lock, 2011; Luftman & Derksen, 2012; Rajterič, 2010; Rayner & Schlegel, 2008).

2.2.1.4 AMR Research's Business Intelligence/Performance Management Maturity Model, Version 2

In 2010 AMR Research Inc. was acquired by the Gartner Inc. for \$64 million, and before acquisition its focus was research in BI and performance management. The AMR Research's Business Intelligence/Performance Management Maturity Model, Version 2, was developed before the acquisition (Hagert, 2006; Rajterič, 2010). According to Hagert (2006) the model consisted of an improved four-level framework for BI and performance

management. The maturity levels in the model were Reacting, Anticipating, and Collaborating and Orchestrating levels.

a) Reacting Level

Organizations at this maturity level, ask themselves where they have been in terms of BI and performance management. Most BI projects at this level are of tactical nature, dealing operational data access and reduction of reporting delays. Organizations at this maturity level also focus on increasing the visibility, efficiency and success of individual business units (Hagert, 2006; Rajterič, 2010). Data is maintained at departmental level, with the reports characterised by static historical events. BI applications depend largely on desktop tools and ad-hoc queries developed by individuals with very little technical knowledge (Hagert, 2006; Rajterič, 2010).

b) Anticipating Level

The BI projects at this level are more strategic, visible within the individual business units and the related business units. Business units query themselves on where they are in terms of BI implementations. At this maturity level, the data is delivered close to real-time to start to report on current business efficiencies and success (Hagert, 2006; Rajterič, 2010). BI tools such as dashboards are used as basic user information tools (Hagert, 2006; Rajterič, 2010).

c) Collaborating Level

At this maturity level, business is driven by clearly defined and monitored operational and financial key performance indicators. The individual business units are well aware of the value gained from BI and business goals alignment. Fact-based decisions that are represented as reports and dashboards are appreciated throughout the organization (Hagert, 2006; Javadi & Dastjerdia, 2011; Rajterič, 2010). The dashboards and the key performance indicators are used to consolidate the business objectives and the resources with the organization. The data generated by BI systems at this level can be used for planning and predicting future business actions.

d) Orchestrating Level

At this maturity level, business is driven by measurable success factors. The business goal identification is basically steered from top management filtering down through the organization. Expectations are clearly defined for all business units and aligned with BI

initiatives (Rajterič, 2010). The philosophical, cultural and technology aspects are jointly considered for the BI and performance management initiatives within the organization.

2.2.1.5 Business Intelligence Maturity Hierarchy

This model consists of four stages which have knowledge management as the backbone. The four stages in the hierarchical maturity model are data, information, knowledge and wisdom (Deng, 2007; Fedouaki, Okar, & El Alami, 2013; Rajterič, 2010), and are articulated as follows:

Stage 1: Data

The major goal at the data stage of the model is to establish integrated, clean and high quality data (Fedouaki et al., 2013). At this maturity level, the organization gathers, standardizes and keeps data from different sources consistent (Deng, 2007; Fedouaki et al., 2013; Rajterič, 2010). These processes undertaken at this stage stimulate the need for data warehousing and BI projects.

Stage 2: Information

At this stage the organization assigns meaning to the data and persist on using high quality and integrated data (Fedouaki et al., 2013). The upper level of this stage assists organizations in identifying critical success factors and the key performance indicators. These information assets on business performance and activities are represented as dashboards which are easy to read and discern (Fedouaki et al., 2013; Rajterič, 2010).

Stage 3: Knowledge

According to Fedouaki et al. (2013) and Rajterič (2010), at this stage, BI systems perform what-if analysis, search patterns and trends in the data. The knowledge gained in these data analysis and presentation techniques is then used to inform organizational business processes. Neural networks and expert systems can also be found imbedded in the business intelligence systems found at the advanced form of this stage.

Stage 4: Knowledge

Rajterič (2010) stated that at this stage business productivity is paramount more than before. People are afforded to make sound, timely, effective and efficient business decisions based on the data products from the BI systems (Deng, 2007; Fedouaki et al., 2013; Rajterič, 2010). Organizations strive to gain a competitive advantage by being able to deliver in time

their business goals, products and offering quality services (Deng, 2007; Fedouaki et al., 2013; Rajterič, 2010).

2.2.1.6 The Infrastructure Optimization Maturity Model

This BI model was designed to indicate the changes in service management within an organization. Typically it shows how the organization moves from reactive to proactive service management (Rajterič, 2010). The model can assess diverse business areas including the infrastructure and BI. The three classes of infrastructure optimizations assessed by the model are Core Infrastructure Optimization, Business Productivity Infrastructure Optimization, and Application Platform Infrastructure Optimization. Rajterič (2010) stated that business intelligence only fits into the Business Productivity Infrastructure Optimization Class and the Application Platform Infrastructure Optimization class. Using this model, an organization can be placed into basic, standardized, rationalized, or advanced maturity levels.

a) The Business Productivity Infrastructure Optimization Class

This class focusses on simplifying the business processes and integrating with business communication, cooperation, and business management. Business intelligence is achieved by searching and analysing business information. The Information technology management is extremely automated and practical (Rajterič, 2010).

b) The Application Platform Infrastructure Optimization Class

This class focusses on line of business making better decisions based the high quality of information delivered to the users. The Information technology management is also extremely automated and practical (Rajterič, 2010). Users can make decisions on the whole spectrum of the business domain.

2.2.2 An Analysis of the Business Intelligence Maturity Models

The majority of the BI Maturity Models this researcher has presented have been developed by commercial companies (Eckerson, 2012; Gartner, 2014; OCU, 2013; TDWI, 2015). Some software development companies developing BI applications develop maturity models to assess their own software, partners or their customers. The maturity models have been largely embroiled in marketing campaigns by BI software vendors. As Eckerson (2012)

argued, consultant companies have also been involved in developing maturity models. This researcher is of the opinion that, if a maturity model is developed for commercial purposes it has inherent biases. The maturity models developed within this realm are intended to market the BI products for those companies. Of course, some BI maturity models are being developed by experts in data warehousing, business intelligence, data management and performance management (Deng, 2007; Fedouaki et al., 2013; Rajterič, 2010).

The BI maturity models have also been developed to identify the strengths and weaknesses of certain organizational business domains. The BI maturity models consist of various, classic levels of maturity of certain domains, which can then be used for organizational business assessment and development. These maturity levels touch on archetypical IT fields, such as, software applications, data, and the enterprise ICT infrastructure. Some of the models are poorly documented, incomplete and with a chunk of methodological gaps (Lahrmann, Marx, Winter, & Wortmann, 2011). A closer look at well documented models shows that sometimes they are very difficult to comprehend and apply.

2.2.2.1 Critique of the Data Warehouse Institute's Business Intelligence Maturity

The origins of this maturity model is from the data warehouse maturity and has been renamed constantly. Halper & Stodder (2015) have updated it to be TDWI Analytics Model Guide, and the latest offering looking at TDWI Big Data Maturity Model Guide (Halper & Krishnan, 2014). This shows that models are subject to change and grow with time. One common characteristics about the TDWI models is that, they all have five levels of maturity defined and assembled from a technical point of view. TDWI has made the maturity models' evaluation criteria and the classification public. The model has web-based tools available and can be handy in BI assessment maturity.

2.2.2.2 Analysis of the Gartner's Maturity Model for Business Intelligence and Performance Management

The presentation of the Gartner's Maturity Model is non-technical and the maturity is discussed from a business-technical viewpoint. Guidelines for the improvements and challenges that might be faced as the organization is moving from one maturity level to another are clearly documented in the model. The Gartner model has explicit layers and components that have to be integrated as a means of bringing a better defined strategic vision and plan for implementing business intelligences initiatives. One setback that the

model has is that the classification of individual maturity levels is not clearly defined. There is excellent documentation for the model with detailed explanations. Some of these documents are free but some are only available to subscribing customers.

2.2.2.3 Analysis of AMR Research's Business Intelligence and Performance Management Maturity Model

The model was focusing mainly on performance management than the BI domain, and for that reason it earned the name Performance Maturity Model in some circles (Rajterič, 2010, p. 62). The Balanced Scorecard has been the methodology incorporated on the the performance management part of the model (Nudurupati, Bititci, Kumar, & Chan, 2011; Rajterič, 2010). The key focus of the model are technology, people and business processes but a detailed analysis of the model is not achievable. AMR was a consulting company, and was bought by Gartner in 2010.

2.2.2.4 Critique of the Business Information Maturity Model

The model added value in business intelligence maturity assessment by incorporating the organizational culture perspective as a measure of business efficiency. The model takes the perspective that business management and the cultural changes in information usage, would lead to better financial returns in the business. This model used the TDWI model for the technical aspects as they suggested the TDWI online assessment tool for identification of technical risks. This shows the business partnership between DecisionPath the company that developed the Business Information Maturity Model and TDWI. One positive feature is that the model has excellent documentation, though with a patchy description of each of the maturity levels. A list of questions to assist in self-evaluation are available, individual maturity is not well-defined.

2.2.2.5 Analysis of the Business Intelligence Maturity Hierarchy

The model is relatively incomplete, but it brings in the fascinating field of knowledge management, although it is reflected on the names of the maturity levels. The author being a data warehouse expert brought technical considerations into the maturity levels. The documentation is only available on a single page, which impacts on its application and use. The idea that the models revolves around the knowledge management domain, it becomes very difficult to measure as the knowledge management domain itself.

2.2.2.6 Analysis of the Infrastructure Optimization Maturity Model

The Model does not have the individual maturity levels outlined. Although the model is incomplete in the BI area, data warehousing, efficiency of reporting and analysis are the key areas of BI that the model deals with. BI is considered just as one of the parts constituted in the model. The model assumes that it addresses business perspectives of the organization, but it mostly addresses issues of BI products and technologies. As the model addresses BI products, it makes it for marketing purposes rather than being a BI maturity model. The reliability of the results that come from this model are questionable. This is because there are no time constraints, number of participants or how the maturity analysis should be carried out.

2.2.3 Discussions of the Business Intelligence Maturity Models

The proliferation of BI maturity models, is an indication that BI has become an essential element of the information pipeline and an important ingredient of organizational success. The evolution of BI maturity models showed a shift from a technological perspective to core business alignment, competence in BI usage including organizational politics and culture. The BI implementation strategies within organizations now include leveraging existing technologies and cementing a broad solution architecture. This entails that BI has grown into a business priority, rather than being solely a techno-centric organizational priority.

During the wake of the metamorphosis of BI systems, maturity models have filled the gaps in the design and the evolving structures of the BI systems. BI maturity models have been predominantly used to identify the strengths and weaknesses of certain organizational domains or the organization as a whole (Lahrmann et al., 2011). Classic IT topics have, however dominated the breadth and depth of the BI maturity models. The models do not have clear link links between lines of business and IT, BI usage metrics, and the organizational performance. This researcher did not find explicit theoretical or empirical models that form the foundations of the BI maturity models. Furthermore, this researcher thinks, that having generalised maturity models for domains is not a practical approach. Having said that, this researcher saw that BI maturity models have also been developed for the higher education sector. In the following section a look at some of the BI maturity models that have been developed for the education sector.

2.2.4 Business Intelligence Maturity Models in Higher Education

Managers have used BI maturity models to identify and explore the strengths and weaknesses of BI initiatives within their organizations. A wide range of maturity models have been developed, which have been focussing mainly on technical details of the BI systems. These models have also been developed mainly in for the corporate world, with higher education lagging behind. The maturity models also lacked theoretical models, BI deployment strategies, BI usage, assessing the impact of BI and linking the BI initiative to organizational performance (Lahrmann et al., 2011). The current models have significant gaps in assessing the maturity levels of BI initiatives in higher education. Organizations such as JISC and OCU (JISC, 2014; OCU, 2013) came up with maturity models for the higher education sector. The BI maturity models for the higher education sector this researcher will look at are, the Maturity Model for Institutional Intelligence v1.0 developed by the Oficina de Cooperacion Universitaria (OCU), from Spain (OCU, 2013) and JISC BI InfoKit (JISC, 2014).

2.2.4.1 OCU's Maturity Model for Institutional Intelligence v1.0

The model has been developed as part of a larger project about Business intelligence in higher education (OCU, 2013, p. 4). This model was conceived based on the experiences of the contributors in the higher education sector. According to OCU (2013) the model was developed for higher education institutions to:

- identify their current BI maturity levels,
- set their desired maturity levels,
- to identify dimensions of potential improvement, and use them to develop a roadmap or plan to evolve their institutional intelligence initiative to a desired level
- Share a common language to describe a situation in the road to institutional intelligence excellence, hence allowing for comparisons and benchmarking among institutions.

The model is based on the assessment of nine dimensions. The dimensions are specific, measurable, exhaustive, and distinct BI capability areas, process areas, or design objects structuring the fields of interests (Lahrmann et al., 2011). According to OCU (2013), the nine dimensions in the model value are:

- The existence and organization of an institutional intelligence team

- The breadth of scope of the institutional intelligence platform in terms of key functional areas included
- The role of business units in the information supply chain
- The level of sophistication of the data products being offered to the users
- The coverage of the potential universe of users
- The role of the users of the resulting data products
- The effective addressing of the most relevant aspects of data management
- The perceived business value of the data products being offered
- The positioning of the institutional intelligence initiative in the institutional strategy

2.2.4.1.1 The Assessment Procedure of the OCU's Maturity Model for Institutional Intelligence

Each of the nine dimensions are expressed in five consecutive levels of increased maturity (OCU, 2013, p. 5). The five levels of maturity for each of the nine dimension are absent, initial, expanded, consolidated and institutionalized, of which they are expressed by a number from 1 to 5. The following is a brief explanation of these levels.

- i) **Absent** means that no formal institutional intelligence initiative is in place or the state it is not perceivable. The usage of institutional data assets is limited to operational contexts.
- ii) The **initial** maturity level indicate data as a valuable asset, and must be provided to address efficient users' needs in an efficient, and trustworthy ways. Small scale or individual departments' success stories regarding data analysis services may be recorded at this maturity level.
- iii) The **expanding** maturity level entails that the potential of data to empower the institution at all levels is now clearly perceived. At this maturity level, the desire to build on the small local institutional intelligence success stories, and translate these into global success stories is recognized (OCU, 2013). Local BI initiatives are subsequently substituted by globalized initiatives at this maturity level.
- iv) The **consolidated** maturity level has global, visible, valued and clearly established permanent BI initiatives. This level of maturity results in effective internal organizational decision-making processes. The data assets targeting different users

and organizational departments are actively used effectively and efficiently within the organization.

- v) The **institutionalized** maturity level, sees the BI initiative as an integral part of the institutional culture. Extensive sets of data covering key functional areas of the institution are used widely and effectively within the organization.

2.2.4.1.2 Analysis of the OCU's Maturity Model for Institutional Intelligence

The model only assists HEIs to observe the maturity of their existing institutional intelligence initiatives. In that regard the model only help institutions to identify their strengths and weaknesses in their BI initiatives. Though the model can assist institutions to better understand their BI initiatives, by making them to be more focussed, and to specify strategies for improvements, it has loopholes. For example, accuracy is sacrificed by the capturing, generalization and simplification of complex business realities. This results in lacunas for interpretations and ambiguity in some instances because the right levels of abstraction are difficulty to reach.

2.2.4.2 Joint Information Systems Committee (JISC) BI InfoKit V. 02

The UK's Joint Information Systems Committee (JISC) BI programme has the aim of working with managers from the UK higher education sector in the areas of business intelligence and BI systems (JISC, 2014). The OCU's Maturity Model for Institutional Intelligence is the foundation of the Joint Information Systems Committee (JISC) BI InfoKit (JISC, 2014). The first version of the BI InfoKit was developed in 2011, and marked the birth of eleven BI projects funded by JISC within the UK higher education sector. The experiences gained from these projects, lead to the development of the Version 2, Bi InfoKit, which was aligned to current BI practices and thinking (JISC, 2014). The JISC BI InfoKit version 2, addresses the following dimensions: business case, people and organizational issues, data issues, and project management.

2.2.4.2.1 Analysis of the JISC BI InfoKit

The measurement and evaluation of the dimensions of the JISC BI InfoKit is based on the OCU's Maturity Model for Institutional Intelligence and briefly explained as follows:

- The **business case dimension**, indicates that it is imperative to intertwine BI with the strategic objectives and agendas of the institution. Measurable and meaningful

business metrics need to be identified in order to demonstrate BI success. It is also important to benchmark current business performance before any changes to the BI initiative are made (JISC, 2014).

- One of the underestimated element in BI initiatives within higher education institutions are the **people and organizational issues**. Most BI initiatives are easily misguided by concentrating on technical issues, without considering the needs of the users. The JISC BI InfoKit acknowledges the fact that not all BI users will embrace change, and the concerns of users need to be managed. As users embrace BI possibilities, the BI initiative might deviate from its original goals, because of being compromised by evolving possibilities. The project team should be kept intact as much as possible.
- **Data assets** are key to the success of any BI initiative, and these need to be managed and handled with due diligence. The affected data in BI initiatives need to be identified as early as possible and any risk need to be mitigated. Manual data collection is discouraged, as these can minimise processing issues. The JISC BI InfoKit, encourages the consideration of a range and a large volume of data that can be used for predictive models. The InfoKit also encourages multiple ways of data presentations to users. The JISC BI InfoKit does not encourage abstract representations of data but encourages infographics.
- **Project Management** is also a dimension mentioned in JISC BI InfoKit which emphasized that understanding of the business problem is vital if the BI technical solution is to be successful. The BI project might have unexpected or unforeseen issues, and to allow for a contingency plan is key in JISC BI InfoKit. A pilot project, is also encouraged as its roll-out might allow for the prediction of possible logistics and politics with the organization. Starting small may also address issues of scale, apparent complexity of the BI project, data quality issues, system development, business process improvement and change management within the institution.

The JISC BI InfoKit, is different from other BI Maturity models in that it addresses real contextual issues in the higher education sector. It does not emphasize on assessing the dimensions of BI initiative, but advises on addressing real BI problems within the higher education sector.

2.2.4.2.2 Benefits and Demerits of the JISC BI InfoKit

Both the benefits and demerits are highlighted as follows:

a) Benefits

- i) The JISC BI InfoKit provided the step-by-step methodological guidelines in initiating, designing, implementing and assessing BI initiatives within the higher education sector. The InfoKit encouraged anyone who wants to embark on a BI initiative at an institution, to work out what they want to achieve.
- ii) The JISC BI InfoKit also advised on establishing the initial status of the project, that is, where the project is at the beginning. An analysis of the technology available and the different approaches to BI implementation are also considered in the InfoKit. It is only then a business case is established for the BI initiative within the institution.
- iii) Every BI project is different, and the JISC BI InfoKit acknowledged the need of building a strong BI team. In the BI team, there would always be variety in the specific job titles.
- iv) BI reporting tools are emphasized in JISC Infokit. As an example, dashboards and other visualisations that the BI project delivers were mentioned in the BI Infokit. These reporting tools are likely to be its most visible output and, rightly or wrongly, would define the perceived success of the BI project.
- v) The JISC BI InfoKit encouraged the use of Specific, Measurable, Achievable, Results-focused and Time-bound (SMART) targets as a vital concept behind creating the kind of Key Performance Indicators that the BI projects should support. This is important because, developing SMART criteria are, perhaps, less often applied to measuring the success of BI projects within institutions (JISC, 2014).
- vi) Apart from discussing classic IT topics, such as, data, BI software applications and enterprise ICT infrastructure, the JISC BI InfoKit has included other topics, such as, staff, organizational politics and culture, BI usage and BI/IT alignment.
- vii) The JISC BI Infokit implementation model also provided institutions with a conceptual model that helped them to understand and compartmentalise the steps required to realise an efficacious BI system. Institutions could be assisted in predicting and preparing for some of the BI stages they would need to pass through their BI implementations.

b) Demerits

- i) One demerit is that BI projects need skilled people to design, develop, implement and manage the projects within the institution. For example, to have the right dashboards that will sell the BI project to the institution wide stakeholders requires a substantial investment of resources. If the dashboard or even report is wrongly conceptualised, one may find it an uphill struggle to generate any enthusiasm or appetite for the entire BI initiative, regardless of the underlying quality and value of what has been achieved (JISC, 2014).
- ii) An analysis of the JISC BI InfoKit does not point to certain key competencies which institutions need to be prepared to cover in some shape or form when rolling out BI projects. Not all BI projects will involve external vendors and the adoption of new products, either commercial or open source, and in either cases require skilled personnel. For some organizations, their BI requirements can be met, either fully or in part, through a combination of the development of existing technologies and the utilisation of internal expertise. Institutions usually face the dilemma of choosing the right technological route. It is also difficult for institutions to balance a number of competing factors and prioritising the BI initiatives (JISC, 2014).
- iii) The JISC BI InfoKit has methodological gaps, just like other BI maturity models mentioned and studied in this literature. The model does not include its design process, especially the theoretical foundations behind its development. The explanation of the underlying maturity levels is not elucidated which compromises its usage and reliability within a wider spectrum of higher education settings. The JISC BI InfoKit need special attention in terms of its content, methodology, and theoretical foundation behind its development. If this is attended to, this would give validity to its underlying maturity concepts.
- iv) The JISC BI Infokit does not cater for a wider spectrum of higher education systems. There is a need to understand the nature of the broader higher education spectrum for the JISC BI Infokit to be used universally. Each BI initiative within higher education should be contextualised according to the geographical region which it is going to be implemented. A closer look at the higher education in general is necessary, if business intelligence systems suitable within the sector including their respective frameworks are to be implemented. The business intelligence systems suitable for a specific higher education system, can only be developed if its context is deeply understood and conceived.

c) Summary of JISC Business Intelligence Infokit

The JISC BI InfoKit uses the OCU BI Maturity Model to measure different aspects of the institution's BI capability. According to JISC (2014), externally developed maturity models have the advantage of having been developed impartially and drawn from the experience of multiple perspective and experiences. In that way, they can help the institution to examine its strengths and weaknesses from new perspectives and incorporating aspects and elements which might otherwise have not occurred. JISC also argued that if institutions use the same set of metrics it also becomes possible for them to benchmark their performance against each other, or against their peers thereby having a further basis for assessment.

The JISC BI InfoKit is a comprehensive BI maturity model, which start from designing, developing, implementing and assessing and reviewing BI initiatives. A lot of positive elements from this BI InfoKit can be incorporated, if a consolidated BI framework for higher education has to be developed. In addition to the OCU BI Maturity Model which JISC adapted as a model for assessing the BI capabilities of higher education institutions within the UK, they also created a BI Implementation Model (JISC, 2014). In addition to the OCU BI Maturity Model which JISC adapted as a model for assessing the BI capabilities of higher education institutions within the UK, they also created a BI Implementation Model (JISC, 2014).

2.3 Business Intelligence Maturity Levels in Organizations

The literature review revealed that the maturity concept summarizes the central comprehension of BI maturity within organizations. In terms of BI maturity, some organizations might have no explicit BI architecture, and some have enterprise data warehouses, which in turn are at highest levels of maturity. Viewing the BI maturity level in such a perspective is regarded as object-centric. People-centric, view of BI maturity is a comprehensive view of BI within the organization. It is also possible that an organization can use a maturity models that uses a mixed-approach. The BI maturity within an organization should reflect the states of being ready, complete or perfect for BI initiatives. Comprehensive BI maturity models should cover a wide range of business domains including the Higher education. The BI should not only be understood as an IT artefact, but in order to understand its comprehensiveness, organizational business practices, people and their capabilities need to be considered. This researcher argues that, technical maturity on its own does not

lead to BI success. The domain where BI is to be applied need to be thoroughly understood, and in this research, is the South African higher education domain.

2.3.1 Infusion of Business Intelligence in Higher Education

The higher education has a breadth of operations which are characterized by a complex and highly political organizational structure with often conflicting priorities. Its operations stretch from teaching and learning, community engagement, research, construction, retail, alumni relations, public safety, libraries, real estate etc. The organizational boundaries for higher education are very distinct and rely heavily on personal relationships (Fish, 2014). The higher education has been in existence for more than 150 years, and expects to be in existence for the coming centuries (van Louw & Beets, 2008). From a business perspective, the higher education does not expect to be out-of-business (Sharman, 2010; Van Dyk, 2008; van Louw & Beets, 2008). The higher education is usually not driven by short-term objectives, as institutions are driven by three to five year strategic plans. In the higher education sector measuring success or assessing performance is usually perceived as a threat (Fish, 2014).

Decision Making in Higher Education Institutions

The higher education is usually characterised by low staff turnover, and the years of service by staff members is rarely between 10 to 20 years (Falamasir et al., 2010; Fish, 2014; Guster & Brown, 2012). The embracing of change is slow within higher education as staff mostly resort to their old ways of doing things (Briggs, 2014). The management of the higher education is usually collaborative, with most decisions often being made by committees and by consensus (Fish, 2014; Guster & Brown, 2012). The academic freedom and tenure often translates into central administration, against individual departments versus individual faculties versus Senate etc.

Analytical Culture in Higher Education Institutions

There are recent calls within higher education to focus more on the usage of data (Fish, 2014; Guster & Brown, 2012). A greater shift in policies within the higher education sector is apparent and performance-based metrics are being demanded by state agencies (Fish, 2014; Guster & Brown, 2012). One question that can be asked is whether the institutions have reached the stage of having an analytical culture. It is very difficult to distinguish the data analysts and the institutionalization of the data analysis processes within the higher

education (Fish, 2014; Guster & Brown, 2012). The data analysis problem is further augmented by the fact that information silos are relatively high with higher education (Fish, 2014; Guster & Brown, 2012). The calls for data usage in higher education is now expending beyond the historical role of Institutional Research for many institutions to give way to evidence-based decision-making (Fish, 2014; Guster & Brown, 2012). What is not quite clear is whether the higher education is ready for the changes in policy shift, demands for data usage and the need for greater accountability to state agencies.

2.3.1.1 Challenges Faced by Higher Education

There are several challenges being faced by HEIs and among them are as follows:

- **Evolving Technology:** Transformations within the higher education globally has been focussing on providing access to affordable education and increasing throughputs. One of the challenges being faced by the higher education is the evolving technology (Fish, 2014; Guster & Brown, 2012). Social networking, fast computing networks, cloud computing, the access of information anytime, everywhere on a wide spectrum of computing devices is a challenged to the higher education (Fish, 2014; Guster & Brown, 2012; Van Dyk, 2008; van Louw & Beets, 2008). Higher education institutions are also faced with the challenge of reducing costs, and to establish new funding models. There are cuts in state support, yet the state demands for greater affordability of education.
- **Running Cost Reduction:** HEIs are also faced with the challenge of *reducing costs*, and to establish new funding models. There are cuts in state support, yet the state demands for greater affordability of education.
- **Greater Accountability:** Each institution globally is being demanded to establish performance based metrics and assessments. The state requires and demands for more accountability from the institutions (Fish, 2014; Guster & Brown, 2012; Van Dyk, 2008; van Louw & Beets, 2008). The demand for greater accountability entails that institutions should increase financial and operational efficiency.
- **Changing Operational Environments:** The demands placed on HEIs come at a time when their markets are also changing. World-wide the demand for a university degree are high (Fish, 2014; Guster & Brown, 2012; Van Dyk, 2008; van Louw &

Beets, 2008). The student body is also changing with internationalization and varied students' demographics. Globalization and market economies are forcing institutions to expand their local and global footprints (Briggs, 2014; Fish, 2014). The cost of statutory regulatory compliance is also increasing because this require hiring of competent staff. The increased competition with the higher education sector, is also forcing institutions to look at varied course delivery modes. One such initiative that is redefining higher education are the massive open online course (MOOCS).

- **Gaining Competitive Edge:** University leadership faced by statutory obligations and to gain a competitive edge over other institutions they demand for more information. They start to demand for data analytics, dashboards, academic performance metrics and administrative metrics (Fish, 2014). According to Fish (2014), the 2013 EDUCAUSE University Leadership Council, published BI case studies within the USA higher education sector, where the emphasis was on data-driven decisions in higher education. EDUCAUSE is non-profit organization in the USA which helps those who lead, manage, and use information technology to shape strategic IT decisions at every level within higher education (EDUCAUSE, 2014). Decision making in higher education has turned to being data informed and being data driven. The establishment of units that address the data needs in most universities world-wide is a challenge on its own.

2.3.1.2 Business Intelligence Needs in Higher Education

Business Intelligence bring several advantages to a higher education institution. Some of the advantages include the following:

- **Assist in the Management of Higher Education institutions:** Business intelligence can help higher education institutions to better understand all characteristics of the business of education, from academics to finance to operations (Beckett & McComb, 2012; Briggs, 2014). The real-time access to a cross-campus base of precise and comprehensive data backs effective decisions about student performance and institutional lifecycle, course planning, operations, purchasing, budgeting, predicting trends and many more (Beckett & McComb, 2012; Briggs, 2014; Fish, 2014; Guster & Brown, 2012) . It is flawless that higher education institutions must ensure firm funding, attract high quality staff and students, improve their course and qualifications offerings and improve on student achievement, the majority have little insight into

how to achieve these targets (Beckett & McComb, 2012; Briggs, 2014; Falamasir et al., 2010).

- **Data Integration Capabilities:** As mentioned by Fish (2014), data assets in higher education exist as structural silos, with an abundance of paper reporting, augmented by manual financial processes. This results in higher education institutions wasting valuable resources and inhibiting the access to the real-time information that can deliver deeper awareness into current and future institutional performance. Many higher education institutions are starting to request for better information on which to base their decisions (Beckett & McComb, 2012; Briggs, 2014; Mutanga, 2015). In the corporate realms, such as banking, finance, retail and insurance, business intelligence has been the norm for decades, but in higher education, institutions have been slower on the uptake of BI (Beckett & McComb, 2012; Briggs, 2014; Fish, 2014; Mutanga, 2015).

Institutions are increasingly demanded to set and follow an information agenda, which allows for transformation of their operational data into new intelligence and placing it in the hands of decision-makers across the organization. Data integration and accessing the data needed for better decisions have been customarily been an obstacle for a number of reasons. Most institution have a host of transaction-based ERP systems often with dearth of both data management techniques and reporting proficiencies. Staff often resorts to transcribe the data from operational systems, or from hardcopy financial reports, into shadow systems dominated by spreadsheets. This kind of approach, besides including unwieldly, laborious, labour-intensive processes, shadow systems do not permit exploration on data by different dimensions or drilling down into details, and do not automatically reflect system changes in real time.

- **Consumerization of Higher Education:** Most universities are now being run a lot like business enterprises. Some universities are capable of employing tens of thousands of people and have a significant economic impact annually. As a result, many universities are scrambling to balance the demands of the marketplace with the values of knowledge and education they offer (Briggs, 2014; EDUCAUSE, 2014; Fish, 2014). Knowledge and better education is now being linked to economic growth, and

institutions are forced to put in smarter BI systems as part of their long-term institutional strategy (Briggs, 2014; Fish, 2014; Mutanga, 2015).

2.3.1.3 Need for Business Intelligence

Higher education institutions need business intelligence systems that overtake the role played by shadow systems. The BI alternatives to the shadow systems must be easy to use and provide convincing data consistency and latency. The usability of the data is key to the success of BI systems in higher education. When staff can correlate, compare and analyse data from various years, and they are able to summarize expenses by cost centres, or see budget-to-actual numbers any day of the month, they will appreciate the inherent value of BI systems. Higher education can no longer rely on paper-based processes and siloes of data assets in disparate systems (Briggs, 2014; Fish, 2014; Mutanga, 2015). Institutions require, a broad view of information on their students, lecturers, research, curricula, operations and finance. It is therefore imperative for universities to institutionalize BI systems, which provide the novel intelligence desirable to make education truly effective.

The need for BI in higher education is to counter the fact that, in the past, decisions were more based on results of debates grounded on suppositions and coaxing stakeholders as much as fact. As Mutanga (2015) puts it, most higher education institutions today are making their decisions based on real data and real intelligence. Furthermore, institutions need to adopt a culture of data analysis. Higher education therefore need to embrace analytics and performance management software and data integration processes that bring institutional-wide information together into a single unswerving base. These set of data management components will then prepare staff with business intelligence and planning competences to respond to acute core business questions. There is a myriad of BI systems that have been deployed in the higher education sector, from the USA, Europe, Asia and Africa etc. In the next section, this researcher gives a brief summary of the BI systems that have been deployed within the higher education domain.

2.3.1.4 Business Intelligence Systems Usage in Higher Education

An effective BI system can bring massive benefits to an organization and, many studies have publicised that the use and adoption of BI systems remain low, principally among smaller institutions and companies with resources limitations (Muriithi & Kotzé, 2013). The adoption of BI systems within higher education is even lower than is expected. Business

intelligence systems will allow universities to also discover new and better ways of conducting business. More often higher education institutions find themselves taking several weeks of sifting through spreadsheets and reports to find what the data they need for decision making (Fish, 2014; Guster & Brown, 2012; Muriithi & Kotzé, 2013).

Which systems have been used in higher education? The literature shows that there are over 23 000 educational entities using IBM Cognos alone and approximately over 1000 are higher education institutions (IBM, 2010). A sample of some of the BI systems used in higher education is shown in Table 2.2.

Institution	Country	Business Intelligence System Used
University of Texas	USA	Cognos business intelligence software to better manage the university's financial resources, and also discover new and better ways of conducting business.
University of Colorado	USA	Cognos was used to create seven core financial reports based on revenue/expense statements, balance sheets, journal entries, procurement costs and other financial reports
University of North-Texas	USA	The university chose IBM Cognos software to seamlessly integrate student, financial accounting and HR data so that it can gain insight into a wide range of topics.
University of Wollongong	Australia	The university now uses IBM Cognos business intelligence software to unite information across departments and locations and let users create detailed and high-level management reports, graphical digital dashboards, and KPI monitoring through scorecards.
University of Hawaii	USA	Cognos assist University of Hawaii in deploying a "simple yet robust reporting tool that can gives summary and detail level reports for executives, as well as provide access to the source data for specialized dumps".
North Western University	USA	The University Leverages Cognos BI to Support Research, Pre-Award Reporting
Texas Tech University	USA	Cognos is the reporting tool used at Texas Tech University to retrieve information that is stored in Banner. Data for Accounts Receivable, Budget, Finance, Human Resources, and Student is being accessed using Cognos.
University of Ottawa	Canada	Used Cognos and the Business Intelligence – Enabled Adaptive Enterprise Architecture (BI-EAEA) Framework to produce reports on Grants administration
University of East London	UK	Use Cognos and the JISC BI InfoKit to profile their students.
Open University	UK	Used the JISC BI InfoKit and IBM Cognos in order to reduce the student attrition.
University of Manchester	UK	The JISC BI InfoKit and IBM Cognos was used to monitor progress on the long-term and mandatory strategic targets
Durham University	UK	The JISC BI InfoKit and IBM Cognos was used to benchmark with other institutions and decide on which areas need improvements.
University of Liverpool	UK	JISC BI InfoKit and IBM Cognos were used to develop dashboards for business intelligence management.

Table 2.2: Business Intelligence systems being implemented in higher education institutions

There is a varied degree of data analysis and arriving at insightful information within higher education. According to Muriithi & Kotzé (2013), effective BI systems give decision makers timely access to quality information, permitting them to precisely categorise where the company has been, where it is now and where it needs to be in the future. Higher education is also faced with new and emerging patterns of demands from students, as well as other competing factors. The data analysis across multiple data sources is a relatively new paradigm within higher education as compared to the sectors. The nature of management reporting in higher education can influence decisions taken by governing bodies such as Council, Senate and different Committees.

The data analytics tools themselves are implemented sparingly, and to discover trends, making comparisons and predicting the future with large volumes of data is a challenge (Fish, 2014; Guster & Brown, 2012; Muriithi & Kotzé, 2013). Business intelligence have been purported to bring abundant benefits to organizations, but their adoption and usage particularly in higher education remain significantly low (Fish, 2014; Guster & Brown, 2012; Muriithi & Kotzé, 2013). For example, Muriithi & Kotzé (2013) argued that the most significant barriers to the adoption of BI in South African higher education is cost and lack of in-house skills to design, develop, and maintain their data warehouses. Muriithi & Kotzé (2013) went on further to argue that the state subsidy even if the number of students are increasing for SA public universities is steadily declining compared to previous years. The universities are then demanded to closely monitor their students, in terms admissions, enrolments and completion rates.

Depth of Business Intelligence

The literature had shown that BI is a very broad topic of study, however, this researcher is of the opinion that, if institutions would like to succeed in their core business, it is extremely important to understand the factors that influence BI and learn how to design effective BI strategies. Higher education institutions are generally becoming information-intensive and are rapidly changing (Briggs, 2014; Fish, 2014; IBM, 2010). Business intelligence can be successfully implemented and effectively used in higher education to make intelligent decisions that will enhance the student success rate (Beckett & McComb, 2012; Guster & Brown, 2012). According to Beckett & McComb (2012), many institutions of higher education

still have administrative information systems for student, finance, human resources and usually find it costly to provide data for decision-making.

Importance of Education

Higher education and education in general is a national priority in most countries if not all countries, and these institutions play a pivotal role as agents for national transformation agendas within the various countries (Beckett & McComb, 2012; Briggs, 2014; Fish, 2014). Building a BI strategy that aligns with the goals of the institution, improving on knowledge management, and advances institutional business by making the best use of information. BI penetration into the business processes of the institutions will subsequently assist the institutions with strategic, tactical, and operational decision making (Beckett & McComb, 2012; Falamasir et al., 2010; Guster & Brown, 2012; Muriithi & Kotzé, 2013). Understanding the context of higher education is key in developing a BI strategy for the sector. The BI strategy brings together the powers that motivates the business operations, which include, people, processes, and technology in a collaborative environment. An understanding of the higher education context highlights and shape the approaches that can enable successful acceptance of BI to deliver true business value within higher education.

Diversity in Higher Education Institutions

Every higher education institution is different and has its own set of measurement for success. This researcher is of the view that, the BI framework should be designed in such a way that it effectively supports the execution of strategic objectives of the institution. To incorporate performance management in the BI technology it should be able to support scorecards, drill downs, dashboards, and should convert data into useful information for decision-making and reporting. The use of predictive analytics and automated retrieval of institutional information from anywhere is also an added important characteristic to be included in the BI technology. Generally, most higher education institutions including South African HEIs want to upturn their enrolment, research outputs, throughput, success rates and retention while holding on costs, increasing affordability, safeguarding academic standards and refining teaching and learning standards. This researcher advocates that, before any BI solution is implemented it is important to have a thorough understanding of the context of each of the university. Business intelligence applications are computational agents therefore this researcher advocates for the incorporation of *Context-aware* in the BI framework to be adopted by each institution.

2.4 General Discussions on Context-Aware

According to the Oxford Advanced Dictionary, Student Edition, context is defined as “*the situation in which s^{th} happens and that helps you to understand it.*” The same dictionary defines awareness as “*knowing s^{th} , knowing that s^{th} exists and is important; being interested in s^{th} .*” In the field of computer science, context-aware computing relies on real-time information generated from the analysis of data from many sources to drive automated quotidian business decisions. The data is only meaningful and useful, when it is duly processed, its context extracted and turned into knowledge. In the process of churning out data into meaningful information, the implementation of computing systems that do just that is a very complex process. The CABIF is the researcher’s attempt to streamline important business intelligence implementation use cases, within the SA higher education sector, hence this researcher elaborates on the situatedness of BI systems. This researcher argues that BI practitioners in the SA higher education will take cognizance of the meta-contexts of BI derived.

2.4.1 Explanation of Context-aware computing

Context-aware computing refers to a general class of mobile or pervasive computing systems that can sense their physical environment, and adapt their behaviour accordingly (Anagnostopoulos & Hadjiefthymiades, 2010, 2013; Barbosa et al., 2012) . Lee & Cho (2013) argued that one of the challenges of mobile distributed computing is to exploit the changing environment with a new class of applications that are aware of the context in which they are being run. “*Context is any information that can be used to characterize the situation of an entity. An entity is a person, place or object that is considered relevant to the integration between a user and an application, including the user and the application themselves*” (Anagnostopoulos & Hadjiefthymiades, 2010, 2013). Computing applications may exploit the gathered contexts from different sources in order to provide enhanced services such as environmental monitoring, security surveillance, contextual and situational inference and reasoning for decision support.

2.4.2 Attributes of Context-aware Systems

One of the key attributes of context-aware systems is context collection. Xuea et al. (2013) argued that context collection refers to a process that a collector gathers context in quality and quantity from sources and other collectors in a computing system. The context refers to

the current values of specific contextual constituents that characterise a user activity or situation within a computing system. Generally, in the context-aware archetype applications perceive and react to varying environments in an unattended fashion. To allow for behavioural adaptation, a context-aware application must dynamically obtain context data from diverse functional spaces in the real world, such as databases, homes, shops and persons (Stieglitz & Brockman, 2012; Tront & Hoffman, 2011; Xuea et al., 2013). The ultimate goal of context-aware is to provide information and assistance for the applications to make appropriate decisions in the Right manner, at the Right time and in the Right place.

2.4.3 Variety of Computing Devices

The users of computing devices today are faced with diverse computing devices which can be mobile or fixed devices (Lee & Cho, 2013). These computing devices feature assorted interfaces and are used in various environments. Many important pieces necessary to achieve ubiquitous computing vision are not yet in place (Musumba & Nyongesa, 2013). According to Musumba & Nyongesa (2013), most of the interaction paradigms with today's devices fail to account for major differences between the static desktop and mobile interaction models. Computing devices are now often used in mutable environments, yet do not adjust to those changes very well. While moving away from the desktop model conveys a variety of novel circumstances in which an application may be used, computing devices are infrequently aware of their immediate environments (Lee & Cho, 2013; Musumba & Nyongesa, 2013; Mutanga, 2015).

2.4.4 Operations adjustment to the vicissitudes in the context of use

Context-aware systems can adjust their operations to the vicissitudes in the context of use, without demanding the unequivocal interference of the user, in order to upsurge their usability and effectiveness (Decouchant et al., 2013). Musumba & Nyongesa (2013) agreed to the use of conceptual models and tools to support rapid development of context-aware applications that could better inform empirical investigation of interaction design and social implications of context-aware computing.

2.4.4.1 Advantages of Context – Aware Applications

The following are the advantages:

- **Proficiency in identifying environmental variations:** Context-aware applications are proficient in identifying environmental variations and adjusting their behaviour to new contexts. This researcher has found out from literature that most of the previous

research in Context-aware has been in mobile computing and few studies have applied them to the BI domain. With the emerging trends of real-time business intelligence applications and the diffusion and adoption of mobile technologies in operational environments, this researcher argues that a Context-aware business intelligence framework is important for the higher education landscape. In the BI domain, a context can be a software process, a legacy database or data warehouse, or a functional area within the higher education, where this researcher can gather institutional intelligence on staff, students, assets, finance and space. The premise for a BI system to be context-aware are the inherent business processes of the institution and the underlying data architecture for the BI system.

- **Flexible computing architectures:** Context comprises of location, identities of neighbouring users and objects and changes to those objects. In data architecture, the objects might be dimensions and fact tables in data warehouse. The relationships created within the data model will inform the contexts being affected by each change in the anatomy of the data architecture. The context stretches to cover computing environments, such as available processors, devices accessible for user input and output, network capacity, connectivity, and cost of computing (Decouchant et al., 2013; Fehlberg et al., 2013; Musumba & Nyongesa, 2013).
- **User centric:** The context information acquisition within a data architecture should be able to regulate what a user is demanding to achieve (Musumba & Nyongesa, 2013). In most cases the user's objective is difficult to define directly, context hints are used to aid in deducing this information and notify an application on how best to support the user. Context-awareness signifies a universal model of input (both implicit and explicit), permitting nearly any application to be considered more or less context-aware insofar as it reacts to input and the environment (Musumba & Nyongesa, 2013).

2.4.4.2 Difficulties in designing context-aware information systems

Designers often lack conceptual tools and methods to account for the nature of context and context-awareness (Musumba & Nyongesa, 2013). The choice of context information used in applications is very often determined by context-acquisition tools existing, normally hardware and software sensors. Musumba & Nyongesa (2013) argued that this could demand a number of challenges as the choice of sensors may not be most suitable or

optimal. This further emphasizes that any inadequacies in the construction of the sensors may be broadcasted up to application level and hamper the tractability of the interaction and further evolution of the application. This researcher is of the opinion that one of the contexts in a BI system is its data architecture. Considering an ERP within a university setting, the data warehouse will only be populated by the data from the ERP databases. The quality of the data in data warehouse will solely depend on the various contexts where the data has been captured.

2.4.5 What is this researcher trying to achieve?

In this study, this researcher strives to show that higher education institutions should deploy business intelligence systems based on their contexts and these should have data quality processes embedded in them, with data errors being extracted and corrected. This researcher assumed that, this process will allow for data cleansing processes, which eliminates any dirty data. This researcher also acknowledges the fact that in some instances, missing data should also be reported to the data custodians, so that they access the original records and update them. The institutions' management will then use data as building blocks that provide information that helps to answer a myriad of institutional core business related questions. These data can then be used, for example, to inform the institution's assessment policy, developmental/remedial measures and foundation or bridging courses initiatives. Why is it necessary to develop a context-aware business intelligence framework for South African Higher education? To create the basis to answer this question the following section narrates on the key findings from the literature.

2.5 Discussions of the Literature Findings

From the discussions done this far, the successes that BI implementations have achieved have wide-ranging influences across organizations and business domains. Whilst each organization and industry provides a specific context, researchers have identified a group of more generic factors critical to the success of BI projects. These factors cover a wide spectrum of influences like top management support, market dynamics, data quality of the source systems and BI system usage. The BI maturity models have virtually dominated as conceptual foundations for evaluating and measuring the impact of BI implementations within organizations. The maturity models allow for scoring of different BI activities at different maturity levels. The development of different maturity models adhere to a basic design, which consist of scope, design, populate, test, deploy and maintain (Lahrman et

al., 2011). The designing and populating of the maturity models have used different exploratory research methodologies, which included literature analysis, Delphi studies, case studies and focus groups (Lahrmann et al., 2011).

Various organizations have come up with BI Maturity models suitable for different organizations. In higher education, the JISC BI InfoKit and the OCU model have been designed and are freely accessible. However, this has found out that these models cannot be applied universally in all higher education systems. These models did not pay special attention any theoretical foundations. The explication and validation of the embedded maturity concepts behind these models lack comprehensiveness and methodological rigour. The researcher is of the opinion that an explanation of the theoretical foundations behind each of the BI maturity model will assist in understanding how the different components affect each other. The researcher argues that a comprehensive BI maturity model should be developed which specific for a particular business domain. The findings from literature are as follows:

2.5.1 Important Findings from the Literature

The link between BI maturity, organizational success and the impact of BI initiatives is not quite clear, because of lack of the theoretical foundations behind the construction BI maturity models. The BI maturity models concentrate on addressing classical IT topics rather embracing the organizational structure, the legislative framework governing the operations of the organizations, efficiency and organizational strategies. The alignment of BI strategy, technology alignment, and BI alignment with business strategies are rarely addressed within the maturity models described in literature. There is need to differentiate people, business intelligence users and organizational staff members. The target audience for BI systems should also be embraced as design attribute.

The BI framework adopted by an organization in this researcher's opinion, should reflect the cause and effect of BI systems with the organization. If these are not considered, this researcher is of the opinion that BI systems will have no impact in improving the organizational business processes. The BI initiatives within organizations should be conceptualized based on information systems success models and the inherent underlying conceptual frameworks. Most organizations often see BI as a technology solution, but this researcher argues that many internal and external factors influence the outcome of BI investments. These include the quality of the data sources, funding, the types of industries

in which the organizations compete, the level of support from senior managers and the set of skills of the technical resources. From the above, this researcher is of the view that organizations should deploy BI systems based on their contexts and these should have data quality processes embedded in them.

2.5.2 Lacunas in the BI Systems in SAHEs

Business intelligence systems are being widely accepted as an effective and efficient means of managing the intelligence decision making life cycle of many institutions. More than 50 percent of the South African HEIs have a BI system, which is an indication of moving towards fact-based decision making. One would argue that the implementation of BI systems in South African higher education sector should relatively be easy, judging by the prevalence of such systems within the sector. However, the following voids have been found in most BI implementations in the SA higher education sector:

- **A disjointed higher education legislative framework**, which have a serious negative impact on how institutions plan, implement and make decisions.
- **Organizational culture and behavioural attributes** that are not aligned with technology standards. Organizational politics, different institutional management styles, varying stakeholder expectations make BI implementations fragmented.
- **Multiple disjointed and disparate information systems** used in different core functional systems of the institutions, result in data architecture problems. Many institutions have turned to BI systems as a remedy to this loophole, but most of them lack technology standards capable of harmonising the data from these multiple systems. BI, technology and core business alignment strategies are non-existent in most South African higher education institutions.
- The **ICT governance** in most institutions does not correlate with the data governance. Most higher education executives do not understand the business value of data governance, judging by the fact that data quality activities are not fully integrated into the business intelligence systems life cycle.
- **Lack of skilled manpower** in the BI and Analytics field, coupled by fewer institutional researchers in the South African Higher education sector. South African institutions lack the personnel who plan for BI systems, including lack of personnel who use statistics to plan experiments, obtain data, and then organize, summarize, present, analyse, interpret and draw conclusions based on the data.

- The lack of personnel in the BI and Analytics field, have made South African higher education institutions to be **preyed by technology vendors**. These technology vendors, in most cases claim that their BI systems have solutions to the data woos faced by the institutions. The institutions become stuck into hefty contracts to solutions that not even cover a quarter of their data for decision making needs.
- Most institutions do not have **standard methodological paradigms to approach BI** systems design, development and implementation. For this reason, most institutions have to revert to BI technology vendors to develop, reports, dashboards, scorecards and their data needs and being charged substantial amounts of money.
- The BI systems in most institutions have strong capabilities in showing historical trends and patterns from the data. However, these systems have very **little strengths in predictive capabilities**, or some systems do not have these at all.
- One of the perennial problems within the South African higher education sector is that users still have difficulties in **accessing the data**. If the users have access to the data, the problem is compounded by the time they spent in getting to the data and having a hive of spreadsheets to analyse.
- South African public universities have not been subjected to **BI assessment using the maturity models**. The HEIs do not know where most of their reporting and business analysis reside. There are also problems in identifying who is using the business reports, analysis and the success indicators, that is, the key performance indicators. Another fundamental question that remains unanswered within the sector is to identify the personnel who drive the business intelligence within the sector.
- The **scope of the data extracted** by higher education institutions have increased substantially. The governing bodies within higher education are demanding more insightful information in reporting. The publication of the new regulations for reporting in the Government Gazette, is testimony to the need for better reporting by the DHET.

2.5.3 An Attempt to Address BI Gaps in the South African Higher Education

In order to address these gaps in BI implementations in the SAHEIs, the researcher suggests that the following issues need to be taken into consideration:

- The South African higher education sector need to have strategies for developing business intelligence within the sector. In the business intelligence strategy, the business value brought by the business intelligence should be elucidated.

- The starting point is to have a business intelligence framework for the South African higher education sector, which embrace the underlying business logic within the institutions, and also fulfilling decision making imperatives within the institutions.
- The business intelligence framework should cover the legislative obligations of the institution, institutional data assets, and organizational needs. All these aspects should be integrated into the BI framework and translated into recognized institutional performance metrics.
- The value of data governance should not be underestimated, of course naysayers do not see its business value. The line of business within the institutions should embed data quality processes in their structured or unstructured data, as these will influence the quality of reports that come off the BI systems. The decisions that institutions will make based on the data from the BI systems are just as good as the data that has been fed into those systems.
- Business intelligence must be put on the centre of the efforts of improving the core business of the institutions, and regarded as a critical component of business success. Technology, people and the strategic goals of the institution must become part of the BI strategy and hence fulfilling the needs of the whole organization.
- If a higher education institution wants to leverage the full potential of business intelligence, then the contexts of the line of business need to be reviewed. During the review of business processes, roles of information within the organization might need to be revisited. The changes might include information use, information request definitions and multiple organizational context review, even if it is a change in a unit record of information.

The discussions of the important findings from the literature, the BI design, development and implementation gaps with the SAHEIs, and how to address them prompted the researcher to develop a conceptual BI framework for the SAHEIs. This conceptual CABIF, is constructed using philosophical underpinnings, which will be addressed fully in Chapter 3. The following section give a brief overview of the conceptual CABIF.

2.6 Conceptual Context-Aware Business Intelligence Framework

A research philosophy is a belief about the way in which data about a phenomenon should be gathered, analysed and used. It includes the term epistemology, what is known to be true, as opposed to doxology, what is believed to be true, and it includes numerous

philosophies of research (Hevner & Chatterjee, 2010; Moody, Jacob, & Amrit, 2010; Teddlie & Tashakkori, 2009). As Geerts (2011) argued, the purpose of science, is of converting things *believed* into things *known*: doxa to episteme. Two major research philosophies have been identified in the Western tradition of science, namely positivist (sometimes called scientific) and interpretivist, also known as antipositivist (Mingers, Mutch, & Wilcocks, 2013). The literature review has shown that BI maturity models have practically dominated as the conceptual and practical foundations for evaluating and measuring the impact of BI implementations within organizations. They have basically influenced the design, development, implementation and evaluation of BI systems within organizations.

Using the critical realism (CR) as the research philosophy, this researcher argues that the real world of BI, particularly in SAHEIs, is ontologically stratified and differentiated, hence contextualised. As Mingers et al. (2013) put it, the real world consists of a plurality of structures and generative mechanisms that generate events that occur or do not occur. In the CR point of view and from an epistemological stance, concerning the nature of knowledge claim, the realist approach is non-positivistic, which means that values and facts are intertwined and hard to disentangle (Goes, 2013; Mingers et al., 2013). The BI generative mechanisms residing in the SAHEI BI domain exist independently, and these can be mapped to a conventional BI maturity model capable of producing patterns of institutional BI events.

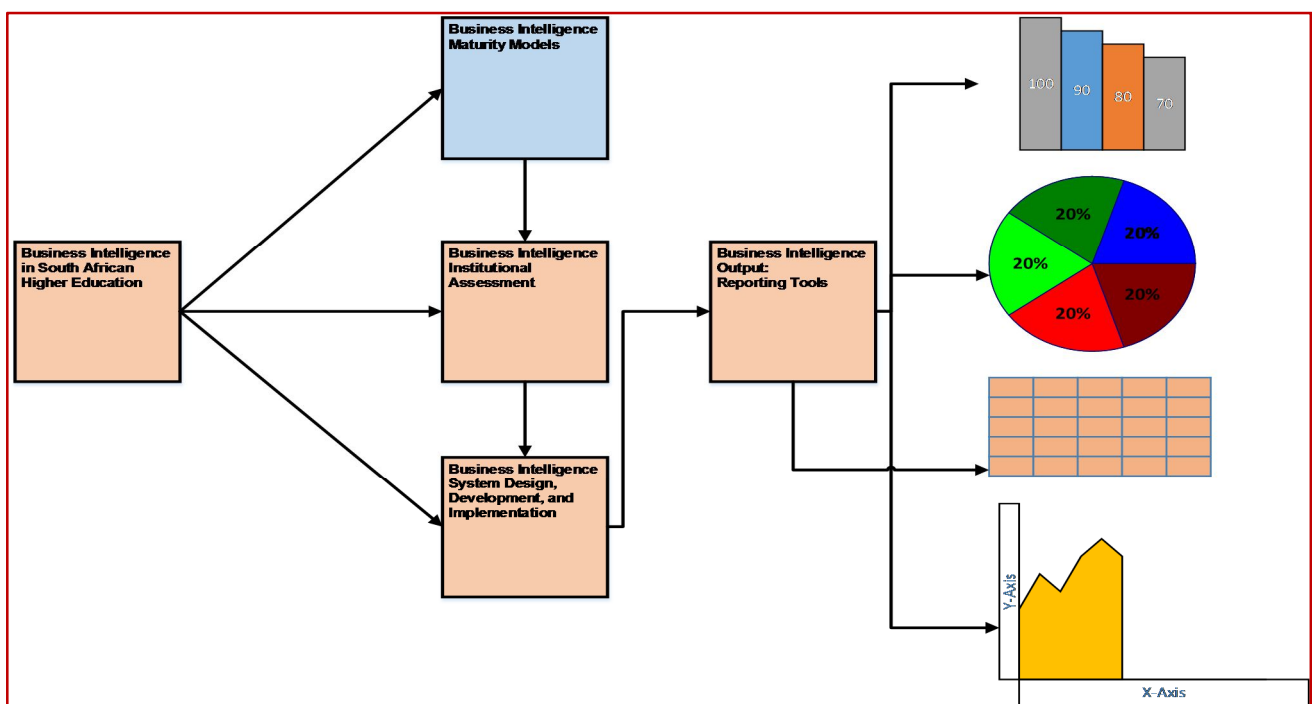


Figure 2.1: Conceptual Context-Aware Business Intelligence Framework

The BI institutional assessment is capable of generating certain behaviours in the SAHEI BI space. The ontological assumptions of CR view of science according to Volkoff & Strong (2013), indicate the domain of reality in which BI mechanisms, events and experiences respectively reside. These events, mechanisms and BI experiences within the SAHEIs, lead to the design, development and implementation of BI systems based on each HEI's context. The process steer the path to BI outputs which, consist of a taxonomy of reports that are aligned to each institutional business needs, decision-making processes and statutory reporting needs. Using CR, this researcher argues that the real domain of BI in SAHEIs consists of underlying theoretical and methodological structures, mechanisms, relationships, behaviours and experiences contextualised to each institution. This is shown in Figure 2.1, as this researcher unpacks the conceptual context-aware BI framework, as a means of deriving and understanding philosophically the nature of the research problem. The researcher's view of the conceptual CABIF, is that it will be validated after effecting the field study within the SAHEIs. It is however, also important to look at conceptual or theoretical frameworks which higher institutions can use in the business intelligence systems adoption process.

2.7 Business Intelligence Systems Adoption Theories

The prominent BI systems adoption theories that have been used particularly in the Small and Medium Scale Enterprises (SMES) have been the diffusion of innovation theory (DOI) and the Technology, Organization and Environment (TOE) framework (Hatta et al., 2015). The DOI theory presents three sets of factors that impact on an organisation's IT adoption intent, namely *“CEO characteristics (innovation and knowledge of the leader toward changes), internal characteristics of organizational structure (centralization, organizational slack, complexity and size), and external characteristics of the organization (system openness)”*, (Hatta et al., 2015, p. 18166). On the other hand the TOE framework incorporates external task environment, organization, and technology as Hatta et al. (2015) argued.

According to Hatta et al. (2015), the environmental context embraces the technology support infrastructure, industry physiognomies and market structure, and government regulation. The organizational context comprises of formal and informal linking structures, collaboration, resource disposal and the organization's management. The technological context contains the innovations and readiness of technology (Hatta et al., 2015). It is also important to note

that different authors, use different taxonomy to describe their contextual variables in the BI system adoption model, as Hatta et al. (2015) explains. Some of the other BI system adoption models used within different organisations included the Lacovou Model, Kirton Adaption Innovation (KAI) inventory, Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), Resource Based Theory, Theory of Planned Behaviour (TPB) and the Risk of Arbitrary Learning (RAL) Model (Hatta et al., 2015).

The researcher looked at each of the BI system adoption theories herein mentioned and decided to embrace an adoption theory that is universal particularly in the IS domain. The technology acceptance model (TAM), with its roots from the theory of reasoned action and behavioural science was found to be more appropriate. The researcher fused TAM as the CABIF adoption theory at the University of Venda. It is also important to note that Chapter 4 and 5, shows the developmental path that the researcher used to come up with the CABIF. Meanwhile it is important to make concluding remarks to the literature, which the researcher has studied.

2.8 Summary of the Literature Review

This chapter critically looks at the origins of BI, and operationally this researcher defined BI as the set of skills, processes, technologies, applications and practices used to leverage an institution's internal and external data assets to support and improve on its decision-making. This researcher also scanned the historical developments of BI, which acknowledged the fact that BI applications require a warehouse of data, some of which were obtained from operational systems, but also other data sources, such as external data, legacy systems or peripheral information systems. This researcher argues that the proliferation of BI maturity models, is an indication that BI has become an essential element of the organizational information pipeline and an important ingredient of organizational success.

In this chapter, this researcher showed that the evolution of BI maturity models exhibit a shift from a technological perspective to core business alignment, competence in BI usage including the nuggets of organizational politics and culture. The BI implementation strategies within organizations have developed with time, to include leveraging existing information and communication technologies and cementing broad BI solution architectures. This entails that BI has grown into a business priority, rather than being solely a techno-centric organizational priority. Having mentioned the strategic importance of BI within various organizations, this researcher had shown that BI in higher education has not been at par

with other organizational domains. Higher education institutions have in most of the cases inherited the BI maturity models from the commercial domain. The literature also shows that there has been some slight methodological movements for BI frameworks for the higher education sector. The OCU models and the JISC BI Infokit are examples of BI frameworks for the higher education sector in Spain and the United Kingdom respectively.

This researcher found out that the one size fits all approach to BI design, development and implementation is not ideal for the higher education sector. The management models of higher education institutions which rely on strong personal relationships is different from other domains. Higher education institutions have a breadth of business processes, and have complex organizational structures. This researcher found out that the analytical culture is not heavily laden within the higher education landscape. Judging on the high organizational boundaries, low turnover, academic freedom and the collaborative form of delegation of authority within higher education, this researcher suggests contextualised BI system for each institution. The need for a contextualised BI solution for SAHEIs has been shown, and a conceptual context-aware BI framework has been developed based on the critical realist research philosophy. This conceptual CABIF, unpacks the tenets of the nature of the research problem, and methodologically show how this researcher arrived at these tenets.

The adoption of BI systems within the higher education needs to be supported by BI systems adoption theories. Whilst there is a plethora of information systems adoption models, the TAM has been preferred. This is because of its independence in terms of the application domain, rather than DOI and TOE, which are more inclined to SMEs. From the various standpoints of technological innovation adoption theories, The TAM was selected as the basis for the advance of the conceptual model of BI system adoption model) used in this study, particularly at the University of Venda. In this study, the researcher reviewed the BI adoption models, especially those related to the adoption of technological innovation in any organization, and found the TAM being more adaptable. The details of the TAM will be explained in detail in Chapter 3, and how it was used in this study is elucidated in Chapter 6.

In conclusion, every higher education institution is unique, as envisaged by the different vision and mission statements they do possess. The uniqueness might be posed by the different mode of delivery of the courses, which is contact, distance or a hybrid form of

delivery that consists of both distance and contact modes of delivery. Within this context, this researcher argues that each university requires a BI system that assists it with its decision-making activities and data quality processes. In this researcher's view, CABIF is therefore imperative within South African higher education sector.

2.8 Concluding Remarks to the Literature Review

The historical overview of Business intelligence shows that, it is continuing to evolve and grow. The BI maturity models originating from commercial companies, have dominated the implementation of BI systems within various organizations. These maturity models have shown little relevance within the higher education sector. This has prompted the OCU and JISC to develop BI frameworks suitable for the Spanish and the UK higher education institutions respectively. Within the SAHEIs, there is a lack of literature and research on BI, and this has been identified as one of the lacunas, which constitutes a research gap to be addressed by this study. This researcher, attempted to decompose this research gap in its reality space, using a philosophical lens and came up with a conceptual CABIF. The following chapter, expounds on critical realism as the philosophical underpinnings behind this research.

Chapter 3 : Context- Aware BI Framework Research Methodology

3.1 Introduction

The purpose of this chapter, is to present the philosophical tradition supporting this research, the research strategy and the empirical techniques applied. It also outlines the latitude and boundaries of the research design, and positions the research in the midst of prevailing research traditions in information systems. The philosophical assumptions underlying this research come from the critical realist tradition in information systems. This tradition implies a subjective epistemology and the ontological belief that reality is socially constructed as Zachariadis, Scott, & Barrett (2013), argued that critical realism can add to IS research by opening up a particular methodological space that lies between empiricism and interpretivism. This chapter, starts by clearly describing an overview of information systems research, the mixed methods research design approach and evidently stating how this research design approach has been used in the study.

This chapter, is also devoted to the debate concerning the philosophical doctrines that apply to IS research. The discussion apprised the researcher about the character of the research problem, the worldview in which this research is situated and the suitable methodological procedure to abide by when solving the problem. This researcher, also discusses the common classes of theory located in research and the research approaches that are used to produce the theory. This study had five research questions which are documented in this chapter, by showing how particular research methods were elicited to answer each of the research questions. The chapter, also covers issues related to how data was collected and measured as a means to respond to each of the research questions. The population and sample, the sampling design, sampling techniques and the sample selection criteria used is also documented in this chapter. Data collection methods, data capturing and editing, and data analysis approaches are also described in this chapter. The researcher winds up the chapter by giving a summary to all the items covered.

3.1.1 Critical realism

Critical realism offers exciting prospects in shifting attention toward the real problems that the world faces and their underlying causes, and away from a focus on data and methods of analysis (Faulkner & Runde, 2013; Mingers et al., 2013; Venkatesh, Brown, & Bala, 2013; Volkoff & Strong, 2013; Zachariadis et al., 2013). Critical realism also offers a robust framework for the use of a variety of methods in order to gain a better understanding of the

meaning and significance of information systems in the contemporary world (Mingers et al., 2013; Volkoff & Strong, 2013). This implies a subjective epistemology and the ontological belief that reality is socially constructed.

3.1.2 Research strategy

Any research that generates or tests a theory have various structures and procedures that direct the research process. A research strategy facilitates an easier understanding and resolution of problems (Mavetera, 2011). As Mavetera (2011) stated there are three principal approaches that can be used to steer a research project, and these are:

- a) Amassing facts on a topic, in which small things of dissimilar kinds have been discovered previously, but where the bits and pieces have not yet been incorporated into a distinct comprehensible body of knowledge;
- b) Observing existing knowledge with new viewpoints and attempting to obtain an improved explanation for a problem that has been heretofore solved and, lastly,
- c) Unravelling a problem for which there is no acknowledged (or apparent) solution.

From the rationale and justification of this research outlined in Chapter 1, this research is concerned with all three strategies. The purpose of the research is to integrate bits and pieces of knowledge that can be added to BI domain for the SAHEI and the epistemological and ontological research body of BI knowledge. It also pursuits for a clarification to the problem of systematic development of BI systems within the SAHEIs. The research strategies typically enlighten the researchers on the nature of research they must embark on. The research strategy adopted was to conduct multiple survey research and non-empirical research in the South African Higher education sector. The fieldwork was conducted at the sites from November 2014 to November 2015. A journal of activities was maintained during the research. The main data collection techniques used in this research study were surveys administered online, face-to-face and telephonically; documentation analysis and a few interviews. The research process followed a mixed methods research approach. This research approach combines quantitative and qualitative research methods in the same research inquiry.

3.2 An Overview of Information Systems Research

This research basically falls into information systems research, as BI system are a brand of management information systems. As Mavetera (2011) indicates IS research, as in

whichever scientific speciality, is directed by dissimilar metaphysical standards, research tactics and a numerous of research practices. Researchers in the IS domain should be persuaded that the wisdom grown from the research procedures can certainly be depended upon (Goes, 2013; Sarker, Xiao, & Bealieu, 2013). Most research in information systems should establish actionable knowledge as the research output (Mavetera, 2011; Zachariadis et al., 2013). The term 'actionable knowledge' means the notions, stratagems and methods that manage or control the actions accomplished in societal traditions by humans (Mavetera, 2011). A research conceptual structure, is consequently required to lead scholars into getting actionable knowledge, which is the product or output of the research. The research framework makes available answers to questions about the nature of the problem under investigation. This usually forms part of the methodological foundation of the research. This researcher agrees with Mavetera (2011) who argued that, the regulating conceptual framework must partake as its foundation the philosophical understandings of nature (social paradigms), the regulatory research paradigms and the research methodologies. This framework commands the research approach to be adopted, the body of research methods to be used and the consequent value of the research procedure.

In addition to this, each research study should build a corpus of academic knowledge in a specific area of study. This intellectual provision is a prerequisite to enhance novel erudition in a particular academic field. This research, has the broad field of IS particularly business intelligence systems as the discipline of study. An academic masterpiece is adjudicated using the conceptual foundations present in an established paradigm of research. The research paradigm should be flawless to individuals who have matching views in the same academic field (Mavetera, 2011). These theoretical foundations in most cases happen to be the theoretical frameworks upon which all activities executed in social practices can be deeply grounded (De Villiers, 2012; Mavetera, 2011). The unceasing study in an academic discipline could result into modifications in the acknowledged theories in the field. This is due to novel ideas that may assume authority and lead to the denunciation of the longstanding ideas. This may also result in a paradigm change in terms of the research practices of the people within the discipline.

3.3 A General Description of Theory

Theory is a term has produced diverse meanings from the scientific community and the world at large. In naysayers' usage, theory may possibly mean an opinion, conjecture or

even speculation. Theory is also literally defined as a lucid group of general propositions used as doctrines for the explanation of a category of phenomena. Scientifically, “theory is defined as a logical, self-consistent model or framework that explains the behaviour as a result of the interaction of some related natural or social phenomena”, (Mavetera, 2011, p. 32). According to Berg (2007), theory is as a set of statements or propositions that are used to describe some aspects of phenomena. Tucker (2009), adds that theory must be a “scientifically tested principle or body of principles that incorporates and explains a significant body of evidence”, (p.9). Theory in brief, must have the power to elucidate some truth about the connections between components of the reality space. Theory can also be generated by considering only part of a sample size of data or evidence needed to verify or refute a hypothesis from the theory. The fact that theory can explain the relationships between natural or social phenomena is not a licence to its acceptance in a study discipline. There different types of theories found in research will be discussed in the next section.

3.3.1 General Types of Theory

In research practice, there are generally two categories of theory, and these are “grand theories and middle-range theories”, (Mavetera, 2011; Volkoff & Strong, 2013), and these are briefly explained below:

a) Grand Theories

Grand theories as are concerned with “more abstract and general explanations of things in a research”, according to Mavetera (2011). They do not evidently specify to this researcher the means of gathering empirical facts, nor do they make available a well-defined standard to this researcher on the methods of data gathering (Mavetera, 2011; Volkoff & Strong, 2013). The usefulness of the grand theory to a researcher’s pursuit to define the practical significance of the research is very minimal.

b) Middle-range theories

Middle-range theories are those “theories that are in-between general theories of social systems which are too remote from particular classes of social behaviour, organization and change to account for what is observed and to those in depth orderly descriptions of particulars that are not generalized at all”(Mavetera, 2011, p. 34). Mid-range theories are vital in guiding an ‘*empirical enquiry*’ and these functions in a restricted territory that tumbles amid grand theories and empirical outcomes. Mavetera (2011) indicated that researchers most often use middle-range theories to understand and explain a limited aspect of social life. Researchers should always to bear in mind that the field or discipline of study influences

the “nature of theory” generated by a specific type of research, because of the ambiguity in the meaning of mid-range theories (Mavetera, 2011; Volkoff & Strong, 2013).

3.3.1.1 The Ontological Character of Theory

The structural nature or the ontological character of what is termed theory is not well defined, especially in the IS discipline as Gregor (2006) elucidated. This ontological nature refers to the “language for talking about the nature and components of theory” (Gregor, 2006; Mavetera, 2011). The Five interrelated types of theories in IS were defined by (Gregor, 2006) and these were:

- i) theory of analysing;
- ii) theory of explaining;
- iii) theory predicting;
- iv) theory of explaining and predicting and,
- v) lastly, theory for design and action.

In this study, this researcher views the theories of analysing, explaining and for design and action, as the categories on which this research study is based. In resume, the theory for analysing classifies characteristics of phenomena by summarizing common attributes that are found in discrete observations. These theories state that the “what is?” of a population sample under study and the most evident examples of this type of theory are frameworks. Although they have a descriptive element in them, they also analyse and summarize the most important salient attributes of phenomena and their relationships thereof. Gregor (2006) emphasized that the most significant aspect is that the relationships may not necessarily be causal relationships. The theory for explaining, which is also known as the theory of understanding put more emphasis on the “how?” and “why?” of the presence of some phenomena and their relationships (Gregor, 2006; Mavetera, 2011). In this category of theory, the focus is not on constructing verifiable predictions but modest enlightenments of “how, when, where and why events” (Gregor, 2006, p.624) happened are adequate.

These explanations usually give rise to process-type theory. The issue here is to provide new insights as to how nature is, that is, insights that are different from those previously known. The research that uses the theory for design and action is solution-driven and this type of research is referred to as design science research (Carlsson, 2011; Gregor, 2006; Gregor & Hevner, 2013). Design science research focuses on the development of the IT artefact, and acknowledge that IS as basically about human activity systems which are in

most instances technologically enabled. The context of design and use is critical, and that research paradigms, practices and activities must embrace such a worldview (Carlsson, 2011; Gregor, 2006; Gregor & Hevner, 2013).

3.4 Information systems Research Forms

Research is either theoretical or empirical, depending on the research problems and their nature. As Mavetera (2011) puts it, “the type of research implicitly or explicitly determines the type of theory generated and is also guided by the research strategy adopted.” The two forms of research are deliberated in the next sections.

3.4.1 Theoretical form of Research

Theoretical research is apprehensive of constructing and purifying a body of abstract comprehension of phenomena and issues. Theory construction can be regarded as a way of conveying order and sense to a multifaceted real world (Carlsson, 2011; Mavetera, 2011). It is a practise of organizing or discovering the set of laws that manage the association between objects or artefacts that constitute specific social phenomena (Carlsson, 2011; Mavetera, 2011). The bringing of order and sense in a complex world is going away from the palpable phenomena to innate, unnoticed stratum of reality in an effort to delineate concepts and general laws in terms of which the muddled fluidity of noticeable facts that can be schematized and elucidated (Mavetera, 2011; Williams & Karahanna, 2013). This notion detangles the romantic meaning of theory. According to Mavetera (2011), it is also important to note that theoretical studies may result into empirical studies.

3.4.2 Empirical Form of Research

Empirical research depends on the belief that, “only knowledge accrued through experience and senses”, is tolerable as Mavetera (2011) argued. It argues that, if ideas are exposed through grand- or middle-range theories, they should be exposed to the thoroughness of testing before the research community can receive them as knowledge (Allen, Brown, Karanasios, & Norman, 2013). Empirical research requires the collection of data or facts relevant to the research problem, and this evidence is usually used to provide evidence to drive the process of theory development (Goes, 2013; Gregor & Hevner, 2013). Mavetera (2011) stated that the key undertaking in empirical research is to get inter-subjective discernible knowledge among actors that rationalizes the being of an occurrence. Data collection processes such as the interview and surveys this researcher used in this study

are examples of the empirical issues referred to here. Whatever type of research is adhered to or one can follow, every researcher must be satisfied with three major types of research tasks.

3.5 Types of Research Tasks in Information Systems

Both the theoretical and empirical types of research are associated with a research task, that is, the activities needed to accomplish a specific type of research. Both theoretical and empirical researches can be conducted through constructive, nomothetic or ideographic research tasks. These three research tasks are discussed in the subsections below.

3.5.1 Constructive Research Tasks

Constructive research also known as inductive research, deals with the construction of frameworks, refinement of concepts or pursuance of technical developments (Carlsson, 2011; Goes, 2013; Mavetera, 2011). Constructive research activities are devoted to construct numerous exterior epistemic intermediaries that operate as a massive new resource of information and knowledge (Mingers et al., 2013; Volkoff & Strong, 2013). Hence, manipulative abduction epitomizes a kind of redeployment of the epistemic and cognitive endeavour to handle objects and information that cannot be instantaneously represented or found internally. Manipulative abduction performs the function of extracting probable concealed constraints by constructing external appropriate investigational structures. Constructive research tasks involve the development of practical or theoretical artefacts or both. These artefacts decipher an explicit domain problem as a means of creating knowledge regarding how the problem can be disentangled, comprehended, explained or modelled. Constructive research tasks yield outcomes which can partake both practical and theoretical significance.

3.5.2 Nomothetic Research Tasks

Nomothetic research is worried about the examination of empirical data and is also branded as deductive research. The general principle behind nomothetic research is to utilize the data set collected during the research enquiry to validate a theory or a hypothesis. Nomothetic research endeavours to discover the evidence to back general scientific laws or theories that cover a whole class of cases (Mavetera, 2011). Sloppily said, its chore is to test suggested theories empirically. The yield of this research activity is the deductive theory.

3.5.2.1 Deductive Theory

In every research, there must be a connection between theory and research. This connection is recognized through the theoretical foundation afforded by using middle-range theories such as deductive theory. The deductive process initializes by creating a hypothesis, which is developed using obtainable knowledge about phenomena in a specific domain and the theoretical contemplations in that domain (Mavetera, 2011). The scholarship of the current literature in the study field can assist in developing these hypotheses. These hypotheses are then exposed to arduous empirical substantiation. Factually, a hypothesis can be equated to a temporary idea that requires to be assessed to find its scholarly value. After the verification and validation of the hypotheses may be accepted or rejected, subject to the conformance of the data to the proposition. The deductive process, therefore, starts with both theory and hypothesis, which later drive the process of data collection (Mavetera, 2011). The concluding thoughts on the repercussions of the data collected on the theory and hypothesis present some component of inductive process to the research. The third research task is called ideographic research.

3.5.3 Ideographic Research Tasks

In contrast to constructive and nomothetic research tasks, an ideographic research task is concerned with exploring particular cases or events and providing the richest picture of what transpires (Mavetera, 2011). A phenomenon is taken independently and considered in its own right in order to comprehend its specific context. It stresses the scrutiny of subjective accounts grounded on specific or close association with daily events. Ideographic research has been suggested to lead to the development of inductive theory. All these research tasks have to be guided by the way researchers conceive their world. What makes up the researcher's reality space? This can be explained using the sociological paradigms.

3.6 Sociological Paradigms Applied to Information Systems Research

A paradigm is defined by the Dictionary.Com online dictionary as a "framework containing the basic assumptions, ways of thinking, and methodology that are commonly accepted by members of a scientific community." Mavetera (2011) claimed that, a framework incorporates postulations, concepts, values and practices that a community of people have regarding reality. It is a means of understanding, discerning and intermingling with phenomena in a reality universe. In the BI domain, Reiser & Wende (2014) refers to a

paradigm as a “data utilization” notion and not as a methodological approach to the development of BI systems. Mavetera (2011) claimed that there are four established sociological paradigms that are now extensively used in the research world and these are:

- i) the functionalist;
- ii) interpretive;
- iii) radical structuralist and
- iv) the neo-humanist paradigms.

These paradigms were developed with four critical questions in mind that always antagonize researchers when they look at the nature of the world (Mavetera, 2011). The first of these questions relates to the nature of reality as Mavetera claimed. It queries whether researchers should accept reality as a given or not. In other words, does reality exist outside the observer’s mind? On the other hand, should people perceive reality as a fabrication of their mind? There is a strong motivation for people to consider reality as a creation of the mind.

The second question according to Mavetera (2011), is concerned with human comprehension and some researchers are satisfied with the fact that understanding things entail people to experience them. Thus, it is imperative to know the bases of human behaviour. The third aspect deliberates on behaviour as a voluntary action. However, some argue that the environment can shape and determine the outcome of a person’s behaviour. The fourth question queries if people should exploit scientific methods in an effort to advance understanding or should they unswervingly experience the situation to understand it. This last question arises based on the factors that dictate human understanding. These four questions prompted the nature of the world to be looked using the ontological and epistemological axes (Carlsson, 2011; Mavetera, 2011).

Ontologically, the world can be considered as a continuum, ranging from a collection of ordered artefacts to a set of artefacts that are always in a state of conflict. Epistemologically, the world again can be considered as a continuum, viewed as consisting of objective artefacts through to subjective artefacts. The word epistemology, derived from the Greek word *episteme*, which means knowledge, looks at the forms of knowledge that can be obtained about the world. It is a concept that focuses on the truthfulness of knowledge relative to the observer of the reality. In his doctoral thesis Mavetera (2011), elucidated on

the four paradigms as used in information systems research which are briefly discussed below.

3.6.1 The Functionalist Paradigm

According to Mavetera (2011), the functionalist paradigm identifies society as being made up of structures that can be combined to form a system. This system can be disintegrated into its functional areas. The paradigm adopts that the social world is ordered and composed of relatively tangible empirical artefacts whose relationships can be acknowledged, studied and measured through approaches derived from the natural sciences. Most information system problems have been constantly viewed and solved using this functionalist perspective (Carlsson, 2011; Mavetera, 2011). According to Mavetera (2011), the IS professionals who work in this paradigm believe that the world, organizations and information systems are clumps of serviceable units that are objective and ordered. This view permits system engineers and IS researchers alike to use reductionist principles when disentangling information system problems. As Mavetera stated, using functionalist approach, researchers undertake a *realist, positivist, determinist* and *nomothetic view* to the world around them.

Functionalists admit to the conception that universal laws and theories valid to the study of natural sciences can also be used to study human behaviour (Carlsson, 2011; Mavetera, 2011). In their mission to find truth, functionalists take the position that, by means of the right instruments and methods, the correct procedures and value free investigation, one can objectively find the truth (Mavetera, 2011). They argue that the truth is “out there” waiting to be exposed. By similar standards, this researcher take up the role of an objective and independent observer disconnected from the problem being researched. The researcher’s locus as an autonomous observer is defied by researchers operating from the interpretive paradigm (Mavetera, 2011; Straub, 2012).

3.6.2 The Interpretive Paradigm

This paradigm is differentiated by the necessity to understand the world as it is, to understand the underlying character of the social world at the level of subjective experience. It pursues clarifications within the participant’s frame of reference, rather than from an objective observer of the action (Mavetera, 2011; Straub, 2012). Even though it dons an organized world, it accepts the presence of a subjective world, in which truth can only be

established as a derivative of the observer. There is a greater need for researchers in this field to get to the level at which one can experience the phenomenon under study. Interpretivists assume a *nominalist*, *anti-positivist* and *voluntarist* view of the world, as Mavetera (2011) puts it. At the methodological level, an ideographic stance is engaged, because, researchers identify the world as an embryonic social process, which is incessantly generated and regenerated by people. This researcher grows into being part of the researched and, only then, can one appreciate the world from inside.

3.6.3 The Radical Structuralist Paradigm

The radical structuralists share an objective departure point with the functionalists but, in addition adopt the stance that radical change is put together into the very nature and structure of contemporary society (Mavetera, 2011; Straub, 2012). It is anticipated that society has intrinsic structural clashes that result from political, economic and social powers, collectively aiming to transform the world. Therefore, “radical structuralism concentrates principally on the structure and exploration of economic, political and social power relationships”, (Mavetera, 2011, p.41). Mavetera (2011) went further to claim that in “addition to sharing the same ontological view with the functionalist paradigm, the radical structuralist paradigm”, believes in society’s drastic modification, its liberation and potentiality. IS researchers are extra concerned with the power interactions that occur between actors in an organization and in how these power dynamisms conglomerate to influence fundamental change in an organization (Mavetera, 2011). The world is regarded as being constituted of artefacts that are continuously in a situation of contradiction and disruptive technologies.

3.7 Information Systems Research Philosophies

Research in IS, requires that one should base the research on some fundamental philosophical conventions. Queries on whatever institutes valid research and what constitute the most suitable research method ought to be responded to (Mavetera, 2011; Straub, 2012). The essential research traditions should be indicated and acknowledged both beforehand and throughout the research process. Also, in order to conduct and evaluate the research, sometimes hidden assumptions need to be identified and unravelled. Three philosophical assumptions are well discussed in (Mavetera, 2011). This researcher agrees with Mavetera (2011), who claimed that these are the ontological, epistemological and human nature, which are habitually used in the scholarship of information systems.

3.7.1 Ontological Grounding to Information Systems Research

In the beginning of an investigation, this researcher should have a critical estimate of what constitutes the world. This researcher should discover what is currently established in the world and what can be generally recognized about this world. Mavetera (2011) stated that, also contained within the search are people's notions of reality. The study of these fundamental conventions made about the phenomena under investigation is termed ontology. The underlying assumptions in ontology exist as a continuum, ranging from nominalism through to realism. In between these two, materialism is found. Nominalism, usually referred to as idealism, is the belief that things are what we, as individuals, think they are. This nominalism positions the social structure of the world and its interpretation at the core of reality construction. The law of causality, cause and effect does not apply in the idealistic ontological position.

In the nominalist view, the presence of structures that are created by individuals through the processes of naming, labelling, and defining concepts is apparent (Carlsson, 2011; Mavetera, 2011). Mavetera argues that there are no invariant structures in the world that are waiting to be discovered "out there". In creating reality, everything needs the consciousness of individual human beings. The meaning given to artefacts is generated and regenerated through interfaces between people, technology and the environment in which they all reside (Carlsson, 2011; Mavetera, 2011). In divergence to the nominalist postulation, realism postulates that the world is defined by objective facets that own tangible characteristics. It embraces the fact that there is an external reality, disconnected from the observer's dogmas and discernments (Mingers et al., 2013; Volkoff & Strong, 2013; Zachariadis et al., 2013). In the middle of nominalism and realism, lies materialism which is a notion that argues that reality exists but that this reality is only limited to material features such as physical objects in the world (Sarker et al., 2013). Materialism does not contemplate on values, beliefs and experiences as adding to the being of the reality.

3.7.1.1 Objectivism

Objectivism deals with the question of whether social entities have an objective reality that is external to social actors or not. As a matter of fact, it speaks to the issue of whether reality, human conceptions and their interpretations exist independently (Mavetera, 2011; Sarker et al., 2013). Objectivism views social phenomena and their meaning as external facts whose

structure and existence cannot be influenced by the observer. This notion accepts that there exists a reality that is external to people who act or interact with social phenomena.

3.7.1.2 Constructionism (Constructivism)

Constructivism on the other hand, discusses whether social activities are the result of some social construction that evolves in an actor-network environment as a result of the perceptions and actions of social actors. This views social phenomena as having emergent properties. Reality is always in a continuous state of construction and reconstruction. Social interaction creates social phenomena and the classes that are thus produced are in a continuous state of revision. The way meaning is assigned a contextual attribute is a typical example of this. In short, social objects and categories are socially constructed. Data can be processed into information. People can deduce the meaning of social artefacts within a context. The sharing or existence of a commonly accepted inter-subjective context leads to general meaning being given to social artefacts. In addition, context is time and place-dependent. As contextual meaning leads to knowledge, knowledge is a social construction. Constructionism can be used to reflect the inadequacy of our knowledge of the social world. There is thus a continuous creation and re-creation of knowledge in the world.

3.7.2 Epistemological Grounding to Information Systems Research

Epistemology is as a type of (valid) knowledge that can be obtained about a phenomenon being studied (Mavetera, 2011; Sarker et al., 2013). Some people may possess knowledge unknowingly since it is the expertise and skills acquired by a person through experience or education (Mavetera, 2011). Mavetera went further to argue that these concepts, as knowledge, are mutable, as several successive generations of researchers have used them to organize knowledge and to conduct scientific inquiries. The epistemological axis runs as a continuum from objectivism (positivism) through to subjectivism (anti-positivism). This continuum covers the positivist notions of the natural sciences and the realist notion (which is usually called critical realism) through to interpretivism. These epistemological notions are discussed below.

3.7.2.1 Positivism versus Anti-Positivism

“The positivist strand believes in realism, that is, that there exists a single view of the real world that we all share. Any observer of this real world will get the same view and results, which will be independent of the observer (observer-free perspective)”, (Mavetera, 2011,

p.45). Mavetera went further to state that, “in the objective world, the social world can be subjected to the same form of enquiry as the natural world, which consists of models and methods.” As human action and institutional aspects inherent in the social systems are totally independent of each other, we can thus have an observer-independent result from such an investigation (Mavetera, 2011). On the other hand, the anti-positivist notion believes in relativism, and relativism accepts that there is no real world “out there” waiting to be discovered (Mavetera, 2011). The entirety happens as an outcome of creations within discrete human minds. Culture, society, language and the relations of these will assist to mould what is perceived by researchers during their investigations (Mavetera, 2011). Matters such as time and place commence to craft some influence in the consequences of interpretations in a relativistic environment. Ideologically, anti-positivists have faith in that all knowledge, both scientific and non-scientific, is an outcome of social construction. Knowledge is fashioned and moulded by the values of a society of interacting actors.

As Mavetera (2011) Claimed, “in IS, there is no hard, real and already tangible information or knowledge that can be found.” The knowledge is of a softer, more subjective, spiritual or even transcendental form that is based on the experiences and insights of the unique and essentially personal nature of the actors (Mavetera, 2011). This results in many problems in this field requiring a subjectivist approach to their solutions. To summarize, based on Mavetera’s analysis, positivists consider all these enlightenments as being grounded on regularity and causal relationships, while anti-positivists merely provide validity of knowledge to the viewpoint of the participant within a given activity. Anti-positivists put up with the notion that knowledge progresses from an objective to a subjective reality.

3.7.3 The Humanistic Grounding in Information Systems Research

This philosophical assumption considers the relationship between human beings (actors) and their environment. The experiences of actors in information systems are not necessarily prescribed products of the environment in which they exist. Their actions are not deterministic, although many developers using the functionalist paradigm approach regard them as deterministic. Determinism leads to the bias of many developers who assume immutable functional models instead of mutable action models. Information system actors, however, create their own experiences through interactions with the environment.

This humanistic-culturalist tradition takes as its epistemology the fact that, in a sociotechnical environment, knowledge is constantly being created through the interaction

of actors. Knowledge is not a pre-given entity but one that is continuously created by the actors in a social setting and manifests itself as a shared cognitive base of the participating actors. The inclusion or existence of people as part of information systems makes these systems non-deterministic, unpredictable and, therefore, socially constructed systems. These three philosophical groundings are used to inform this researcher about the correct research paradigm to use in this study. In addition to the sociological paradigms, they guide this researcher in his choice of the correct pair of world views, i.e. objective-order, objective conflict, subjective-order or subjective-conflict pairs to position the nature of the research problem.

There is a research paradigm that lies between the positivist and interpretive paradigms, which is the realist paradigm. Realism holds that the natural world and the social sciences can and should apply the same kinds of approach to data collection and to its explanation (Angen, 2000; Guba & Lincoln, 1994; Mavetera, 2011). The realist approach can be divided into empirical realism and critical realism. Empirical realism, at times referred to as naïve realism, assumes a perfect correspondence between reality and the terms used to describe it (Carlsson, 2011; Mavetera, 2011). This species of realism also embraces that, with the use of suitable methods, reality can be evidently distinguished or understood. On the other hand, critical realism trusts in an external reality that occurs and is distinct from the observer's account of it. Mavetera stated that critical realism contends that the social world can be understood and so changed, if we succeed to identify the structures at play that create events and discourses in the social world.

3.8 Critical Realism as the Philosophical Underpinnings of this Research

Critical realism (CR) supports a sturdily realist ontology that there is an existing, causally efficacious, world independent of our knowledge (Allen et al., 2013; Faulkner & Runde, 2013; Mingers et al., 2013). CR has the realist property in that, it guards this against both classical positivism that would reduce the world to that which can be empirically observed and measured, and the various forms of constructivism that would reduce the world to our human knowledge of it (Venkatesh et al., 2013; Volkoff & Strong, 2013; Zachariadis et al., 2013). Mingers et al. (2013) argued that CR recognizes, based on the Kantian sense, that the human access to this world is in fact limited and always arbitrated by the human's perceptual and theoretical lenses.

3.8.1 Epistemological Features of Critical Realism

According to Mingers et al. (2013), CR accepts epistemic relativity (that knowledge is always local and historical), but not judgmental relativity (that all viewpoints must be equally valid). CR consents the being of diverse types of objects of knowledge, be it physical, social, and conceptual and which have dissimilar ontological and epistemological characteristics (Mingers et al., 2013; Volkoff & Strong, 2013). The diverse ontological and epistemological characteristics therefore require a range of different research methods and methodologies to access them. According to Mingers et al. (2013), CR was developed initially by way of arguments contrary to both the empiricist vision of science as personified in positivism and the idealist view of (social) science as embodied in constructivism or interpretivism. Later, it also engaged with postmodernism and other irrealist standpoints. Through this entrenched consideration of other positions it advanced its own methodology, which was most fully articulated within a dialectical perspective (Faulkner & Runde, 2013; Mingers et al., 2013).

The starting point of CR was to dispute, precisely against empiricism and positivism, that science is not just about recording perpetual concurrences of noticeable events, as the Humean view of causation embedded in positivism would have it, but is about *objects*, *entities* and *structures* that exist (even though perhaps unobservable) and generate the events that we observe (Mingers et al., 2013; Venkatesh et al., 2013; Zachariadis et al., 2013). The form of the argument is a transcendental one, as it begins with some accepted phenomenon and asks what the world must be like for this to occur. In this case, what is accepted by both empiricism and many forms of idealism is that we do have perceptual experience of the world, and that science is carried out through experimental activity in which scientists bring about particular outcomes.

The argument posed by Mingers et al. (2013) is that neither empiricism nor idealism can efficaciously expound on these manifestations and that they demand some practice of realist ontology. Fundamentally, there must be some intransitive domain of object and events, independent of the human perceptions about them, which can indeed become objects of human knowledge (Mingers et al., 2013; Venkatesh et al., 2013; Zachariadis et al., 2013). Empiricism and strong forms of idealism or constructivism make the mistake of epistemic fallacy (Faulkner & Runde, 2013; Mingers et al., 2013; Volkoff & Strong, 2013). The epistemic fallacy entails reducing the ontological domain of existence to the epistemological

domain of knowledge, that is, statements about being are translated into ones about our (human) knowledge or experience of being (Mingers et al., 2013; Volkoff & Strong, 2013).

3.8.2 Epistemological Fallacy

The epistemic fallacy entails that the empiricist, believes that issues which cannot be perceived cannot be, and the conventionalist believes that, limitations of human knowledge are taken to be limitations on the being itself (Mingers et al., 2013; Volkoff & Strong, 2013). In contrast, the realist asserts the primacy of ontology, in that the world would exist whether or not humans did. As Mingers et al., (2013) puts it, the empiricist identification of causal laws with empirical consistencies embraces a dual reduction; that of laws to events and events to experiences of those events. The response is that there must be long-term entities, physical (e.g., atoms or organisms), social (e.g., the market or the family) or conceptual (e.g., categories or ideas), observable or not, that have powers or tendencies to act in particular ways (Faulkner & Runde, 2013; Mingers et al., 2013; Volkoff & Strong, 2013) . It is the continual operation and interaction of these mechanisms that generates the flux of events.

3.8.3 Distinction of Critical Realism from other Philosophical Research Paradigms

As Mingers et al., (2013) puts it, the heart of the argument about CR and other research philosophies, is that of a causal criterion for existence rather than a perceptual one. The empiricist, regards only that which can be perceived can exist, whereas for a realist, having a causal consequence on the world infers existence, irrespective of perceptibility (Mingers et al., 2013). This view of causal mechanisms is at the heart of critical realism and, independently, is also becoming dominant within mainstream philosophy of science (Mingers et al., 2013). Faulkner & Runde (2013) identified a gap in IS-related applications of critical realism. In a study about CR and Affordances in Theorizing IT Associated Organizational Change Processes, Volkoff & Strong (2013), provided a theory in developing and operationalizing critical realism's concept of generative mechanism for an IS context. Volkoff & Strong (2013), referred to affordance as to what is offered, provided, or furnished to someone or something by an object. An affordance exists at what critical realists refer to as the domain of the real.

Volkoff and Strong (2013) contributed to CR by providing a consistent use of the concept and a clear ontology. They showed how affordances are an explicit form of generative

mechanism. Their subsequent contribution was to provide to CR and generative mechanisms the opportunity for more fine-grained explanations of causality, through the development of middle range theory using the concept of affordance. Allen et al. (2013) also contributed to the CR theory. They argued that critical realism and activity theory can complement one another in forging a “philosophically coherent yet practically attuned materialist framework for understanding IS and the way it supports and transforms work activity”.

Zachariadis et al. (2013) examined key CR ideas on causation, validity, and generalizability, and illustrated how these shape the logic of inference in the research process through retrodution. The work of Zachariadis et al. (2013) made a major contribution in using mixed-methods research within a critical realist framework. As they pointed out, that the methodological implications of CR for mixed methods research have been largely unexplored. They usefully explored what happens when working within CR’s stratified ontology and focusing on underlying mechanisms, and demonstrated that this refocusing leads to a different understanding of concepts of reliability, validity, and inference quality.

3.8.4 Critical Realism as the Philosophical Underpinning for this Research

This researcher concurs with Zachariadis et al. (2013), who stated that in designing mixed-methods research, the role of quantitative methods within CR is largely descriptive. This is because generalizations and correlations between variables alone cannot uncover evidence regarding causal mechanisms that generate actual events observed, or predict future incidents. Zachariadis et al. (2013) went further to state that, qualitative methods within CR have a deeper role, as they are more proficient of unfolding a phenomenon, building propositions, and detecting structured connections between complex mechanisms. CR therefore does not pledge itself to a solitary brand of research paradigm. This researcher chose critical realism as the philosophical underpinning for this research, because of its acceptance to methodological pluralism in an inquiry. CR’s inclusion of methodological pluralism is grounded on its ontological and epistemological assumptions, thus preserving a strong link between meta-theory and method.

Business intelligence systems in South African higher education as the object of this research has different characteristics. This researcher used a mixed-method research design strategy (i.e., a variety of methods in the same research study) and CR supports this research design (Mingers et al., 2013; Volkoff & Strong, 2013). In this research study, apart

from making important theoretical contributions to developing critical realist-informed research methods, this researcher also wanted to contribute strongly to the applicability of a context-aware business intelligence framework adoption in the South African Higher education. This researcher wanted to achieve this by illustrating how the logic of retroduction can lead to a dynamic interaction between research methods comprising of continuous comparisons. In that way, the mixed methods research tactic this researcher deployed, would enable to move between a positioned narrative and statistical explanations of the research population in order to unearth the generative mechanisms and make vigorous meta-inferences.

3.9 Information Systems and Research Paradigms

The research archetype to be adhered to in IS research, is dependent on the ontological and epistemological standpoints taken by this researcher vis-à-vis the research problem. There are primarily two constituencies of research paradigms, which a research project can go along with. These strands, herein referred to as research paradigms, are qualitative and quantitative paradigms. The research paradigms can be equated to a strategy, as a thinking approach or as a means of viewing at things.

3.9.1 Quantitative Research Paradigm

This research paradigm, if viewed from a sociological point of view, is usually used within the functionalist context. Quantitative research, is grounded on the conjecture that natural phenomena can be enumerated in numeric terms. The construction of statistics, metrics, or numbers) that can be utilised to define phenomena (objects and relationships) under study are the emphasis of this brand of research (Mavetera, 2011; Sarker et al., 2013; Venkatesh et al., 2013). Mavetera citing Bryman (2004) stated that, in addition to quantification in the gathering and examination of data, quantitative research approaches involve the following:

- They follow a deductive approach to the relationship between theory and research stressing on the testing of theories.
- They include the practices and norms of the natural scientific model. Hence, they follow the positivist epistemological stance.
- The paradigm considers social reality as an external objective reality from an ontological stance.

3.9.2 Qualitative Research Paradigm

Qualitative research, involves studies that do not attempt to quantify their results through statistical summary or analysis. Qualitative studies, typically involve data collection techniques that involve protocols without formal measurement (Mutanga, 2013). The main focus of qualitative research, is on exploring issues and to have a deeper understanding of phenomena by answering questions. Qualitative research is used to gain insight into people's attitudes, behaviours, value systems, concerns, motivations, aspirations, culture or lifestyles. Some of the activities in a qualitative research study, include building holistic pictures, detailed reporting of informants' views, and analysing words (Mutanga, 2013; Sharma & Chandel, 2013). The study is normally conducted in natural settings of the research participants.

The purpose of qualitative research, is to have a description of events and their meanings to those that participated in them. The qualitative research reports are narrative in nature describing occurrences and objects of interest by giving the range and frequency of the observed perspectives (Mutanga, 2013; Sarker et al., 2013). Qualitative research methods are useful in understanding how individuals perceive their world. They also show the perceptions and intentions of individuals in different situations that determine their behaviour. Qualitative research is also suitable to explore phenomena, finding explanations, and to provide concrete and detailed illustrations of phenomena. Mavetera (2011), argued that the research in this paradigm, has been associated with the interpretivist and relativist positions, as expounded from the epistemological anti-positivist view of the real world. The qualitative research paradigm, negates the generalizability, which is inherent in models and theories of the natural sciences. The qualitative paradigm as Mavetera stated, does not imply the absence of numbers in the research. It gives emphasis on how the analyses which led to the conclusion or findings of the research were executed (Mavetera, 2011).

When conducting qualitative research, it is very difficult to use a highly systematic research approach. A systematic approach may lead to the loss of information that is potentially available in qualitative research data. Mavetera citing Bryman (2004) summarizes the basic tenets of qualitative approach as follows:

- It relies on descriptions of phenomena during the collection and analysis of data.
- It generally uses an inductive approach to the relationship between theory and research and emphasizes the generation of theories.
- It relies solely on the way in which people interpret their social world (interpretivism).

- It views social reality as a constantly shifting emergent property of individuals' creation.

3.10 Approaches to Information Systems Research

The two basic approaches to information systems research are positivist or an anti-positivist. Mavetera (2011), argued that the research problem space, like the reality space, cannot be treated as discrete but as a continuum. It is important to note that, some research problems lie along the line joining the positivist and the anti-positivist poles. It is advisable to blend the positivist approaches and the interpretive approaches that are usually used by the anti-positivists (Mavetera, 2011). These research problems are therefore, dealt with using the critical realist approach. The three research approaches: positivism, interpretivism and critical realism, may be regarded as the theoretical perspectives or frameworks to research.

3.10.1 The Positivist Research Approach

The positivist research paradigm, embraces that knowledge is absolute and objective and that a distinct objective reality occurs outside the peripheries of human beings. Positivism is associated with the scientific method, whereby knowledge is unearthed by measured empirical processes, such as experiments. According to De Villiers (2012), positivist research aims for an exact, value-free representation of reality. Positivists trust that the scientist's interpretation of reality bluntly reveals that reality and that the matter should be to uncover descriptions of human behaviour. The positivist approach relies on crude and superficial data collection during the research process (Carlsson, 2011; Mavetera, 2011). Positivism calls for a study that is detached from the subjective elements of experience and it treats the subject of research as a subject with the ability to develop general theories of universal applicability (Goes, 2013; Mavetera, 2011).

In some situations, the theories must be offered and confirmed. The basic goal is to control the influence of this researcher on the results. Mavetera stated that "positivist research regards true knowledge from research because of an observation or experience of real phenomena in an objective and real world". The output of positivist research is considered as undeniable facts that are timeless and without any committed social values (Goes, 2013; Mavetera, 2011). This researcher does not influence the results of an investigation and, if all variables are kept constant, other researchers may reach the same conclusion as the first researcher, regardless of differences in personal traits. Mavetera citing Bryman (2004) stated the following as the most accepted notions in positivism:

- Only phenomena and, hence, knowledge established by the senses can legitimately be justified as knowledge. This is referred to as the principle of *phenomenalism*.
- The rationale of theory is to produce hypotheses that is capable of being tested. These hypotheses function to provide enlightenment to laws to be evaluated. This is referred to as the principle of *deductivism*.
- Knowledge can only be unearthed through the fact-collection processes. This provides the basis for the creation of laws and is called the principle of *inductivism*.
- Science can only be handled in a value-free way. This is called the principle of *objectivism*.
- Lastly, scientific assertions are in contrast with normative statements. Mavetera argued that a true scientist belongs in the scientific domain and this supports the conception that real knowledge being collected and sanctioned by the senses. Normative statements cannot, however, be confirmed by the senses.

3.10.2 The Interpretivist Research Approach

Interpretivism is a research doctrine that underscores the prominence of interpretation and observation in efforts to comprehend the social world. It shares the understanding that the subject of research in the social sciences, that is, people and their institutions, is primarily dissimilar from that in the natural sciences and is in fact an integral part of the qualitative research paradigm (Goes, 2013; Mavetera, 2011). The epistemological foundation of interpretivism is bound in the understanding of human behaviour that is accomplished through sequences of cyclic procedures of interpretation that are designated as the hermeneutic cycle. Interpretive research stresses on understanding human action and not on the powers subjected on it.

Mavetera went further to state that, interpretive studies commonly endeavour to understand phenomena through the connotations that people designate to them. Hermeneutic–phenomenological tradition is also customarily linked with interpretivist research, thus regarded as being very fluid. The interpretivist paradigm supports relativist ontology and transactional or subjectivist epistemology. Relativist ontology assumes that reality as we know it is constructed intersubjectively through the meanings and understandings developed socially and experientially. Transactional or subjectivist epistemology accepts that we cannot isolate ourselves from what we know. This researcher and the object of research are related such that who we are and how we understand the world is a central

part of how we understand ourselves, others and the world (Angen, 2000; Guba & Lincoln, 1994).

3.10.3 The Critical Realism Approach

Critical research, which is grounded on the foundations of critical realism, strikes a balance between positivist qualitative research and interpretive qualitative research. It is based on the fact that any artefact observed by a researcher in society is socially constructed (Mavetera, 2011; Mingers et al., 2013). The critical realist research approach assumes the existence of a domain of structures and mechanisms, events and experiences, which is 'the Real' (Mavetera, 2011; Mingers et al., 2013). These structures may be physical, social, or conceptual and may well be unobservable except through their effects. It also acknowledges that our knowledge is always temporary and is historically and culturally relative and that people do not have observer-independent access to the world (Mavetera, 2011; Mingers et al., 2013). According to Mavetera (2011), critical research is all about evaluation and transformation of the social reality that is the subject of research.

Critical realism paradigm claims that scientists' attempts to contrive the tenets of reality are just one way of attempting to understand or know that reality. There is a difference between the objects that are the emphasis of any research and the terms or concepts that are used to illustrate those objects. This researcher has mentioned already why critical realism was the philosophical choice, and concurs with Mavetera who argued that, although generative mechanisms may not be observable, they are acceptable as long as their effects are observable. The discussions this researcher has made on types of research approaches, research paradigms, philosophical underpinnings in IS research guided this researcher to focus on the nature of the research problem within the SAHEIs.

3.11 The Diagnosis of the Nature of the Research Problem

The dialogue this researcher has done on the philosophical foundations of IS research offers a lens with which the nature of the research problem can be classified. The narrative this researcher has done on the worldviews of research paradigms in summary address three basic concerns with respect a research problem. The concerns that need to be addressed are the ontological stance, the epistemological stance and the humanist stance of the research problem. A clear analysis of the character of the information systems research problems along these three elementary conventions is imperative, since this will be capitalised to apprise the methodological design of the research.

3.11.1 Ontological Diagnosis

South African higher education institutions and their varied management information systems can be considered as vast actor-networks. It is apparent that much of the technological components of these networks can be structurally separated, but, regrettably their influences in the whole system are contra to this postulate. In real terms, the socio-technical nature of the business intelligence problem in SAHEIs, requires the neo-humanist stance to be endorsed. However, this researcher also senses that there are also inadequacies on what can be observed, interpreted and implemented in designing a BI framework, implement it and validate its use. In this researcher's view, what is important is to strike a balance between positivist quantitative research and interpretive qualitative research. The critical realist stance assists in this respect because designing, developing and validating a BI framework requires pluralism of research approaches, methods, and paradigms.

3.11.2 Epistemological Diagnosis

This researcher has made an attempt to develop and provide BI conceptualizations within the SAHEIs. This has been achieved by developing theoretical explanations about the BI phenomena in the world. This process functions at a level comparable to that taken by positivism and interpretivism research philosophies. The CR stance that this researcher used to underpin the development of BI theoretical explanations within SAHEIs and can be considered a "metatheory", rather than a "theory". The knowledge that people have about the world, especially about institutions and their respective information systems is always conditional and in an incessant state of invention and reinvention. The fact that meaning and knowledge have a situated practice that is heavily dependent on the context, the research adopted a relativistic and subjectivist or transactional stance. This researcher also wanted to simultaneously map relations between BI technology and the respondents' views BI systems in use at their institutions. This researcher used the actor/network theory as it assumes that the use of more than one BI systems at an institution is possible.

3.11.3 Humanist Diagnosis

The myriad of problems facing the design, development and implementation of BI systems within SAHEIs, emanate from the fact that BI developers consider institutional problems as deterministic and rational. In view of this, conventional BI development approaches have

been used, which have been posing problems to BI developers and practitioners alike. When solving BI design, development and implementation problems, researchers are advised to assume the voluntarist stance. This supports the fact that humans create their own environment and are neither shaped nor modelled by it. Although this stance has limitations when it comes to implementation information systems products such as BI systems, this researcher considered it unremittingly throughout the study. This researcher however, agrees with Mavetera (2011) who argued that, in the implementation of any information system, the world must be contemplated as being anatomically ordered to some degree. Hence in this case, this researcher subjected the SAHEIs' BI world to some formalisms and conceptualizations which have to fit some defined intention. In summary, this research rejected the objectivist position and calls for the subjectivist acceptance of how people view and interpret reality. Reflecting on the research objectives, this research is apprehensive with the design, creation, modification and interpretation of the business intelligence domain within the South African higher education landscape. Ontologically, this research posits as relativistic, and epistemologically it posits as subjective or transactional throughout.

This researcher has already elaborated that there are primarily two constituencies of research paradigms that any research project can go along with. These are either qualitative or quantitative research paradigms. In Table 3.1 this researcher clearly distinguishes why each of the research question is qualitative, quantitative or is in the field of design science research in information system research.

3.11.4 Classification of the research questions

Research Question	Design Science, Qualitative/Quantitative	Data Collection Instrument
RQ1	Qualitative/Quantitative	Questionnaire/ Surveys
RQ2	Qualitative/Quantitative	Questionnaire/ Surveys
RQ3	Design Science Research, Qualitative/Quantitative	South African Higher Education Document Analysis/ Questionnaire/ Surveys
RQ4	Qualitative	Requirements/Functional Analysis
RQ4.a	Qualitative	Systems Analysis and Design Techniques
RQ4.b	Qualitative	Systems Analysis and Design Techniques, Desktop Research
RQ4.c	Qualitative	Systems Analysis and Design Techniques, Desktop Research
RQ4.d	Quantitative	Survey
RQ4.e	Quantitative	Survey
RQ4.f	Quantitative	Survey / Desktop Research
RQ4.g	Quantitative	Survey / Desktop Research
RQ5	Quantitative	Technology Acceptance Model Survey

Table 3.1: Classification of the research questions

3.11.5 Hypotheses at the University of Venda

The research question that bear a set of hypotheses was question RQ5, the one that measured the adoption and acceptance of the context-aware business intelligence based BI system at the University of Venda. The Technology Acceptance Model was used for the elaboration of the hypotheses for question RQ5. The basic assumption made in this research study was that the age, experience and facilitating factors would have positive affect on the business intelligence system users' motivation. These determinants were taken into account in the formulation of the hypotheses.

Hypothesis 1: There is a negative relationship between perceived usefulness and (a) age of the user and (b) race of the user when using the Context-aware business intelligence solution at University of Venda.

Hypothesis 2: There is a positive relationship between the experience of the user and (a) perceived ease of use and (b) perceived usefulness for using the Context-aware business intelligence solution at the University of Venda.

Hypothesis 3: There is a positive relationship between attitude towards use (a) perceived ease of use and (b) perceived usefulness the of the business intelligence solution.

Hypothesis 4: There is a positive relationship between intentions to use the BI system and (a) age, and (b) attitude towards use of the Context-aware business intelligence solution at University of Venda.

Hypothesis 5: There is a positive relationship between the actual usage, and (a) facilitating factors and (b) intention to use of business intelligence solution at the University of Venda.

3.12 Research Design

In order to provide acceptable answers to the three main research questions, this researcher combined exploratory, multivariate, confirmatory and evaluative studies in a sequential mixed methods research design as shown in Figure 3.1. This has been achieved by using mixed research methods, particularly from the information systems domain. According to Teddlie & Tashakkori (2009), mixed methods research has at its core, the involvement of a research design that uses multiple methods, more than one method or more than one worldview in a single research inquiry. The term third methodological movement (paradigm)

has been attributed to mixed methods research with quantitative, and qualitative movements representing the first and second movements (paradigms) respectively (Teddle & Tashakkori, 2003, 2009; Venkatesh et al., 2013). The mixed research methodology used in this research followed the principles theorised and publicised by Venkatesh et al. (2013) and Zachariadis et al. (2013). The first phase of the research was exploratory in nature, as this researcher elicited opinions about the methodological and theoretical foundations of business intelligence systems, within the South African higher education sector. The second research question required the researcher to choose or develop a business intelligence framework suitable for the South African higher education. This researcher used design science research methodology in order to develop a Context-aware Business Intelligence Framework suitable for the South African Higher Education. This researcher wound up the research by using a customised technology acceptance model survey at the University of Venda. The technology acceptance survey was part of an evaluation of the suitability of the developed CABIF, for the South African higher education sector.

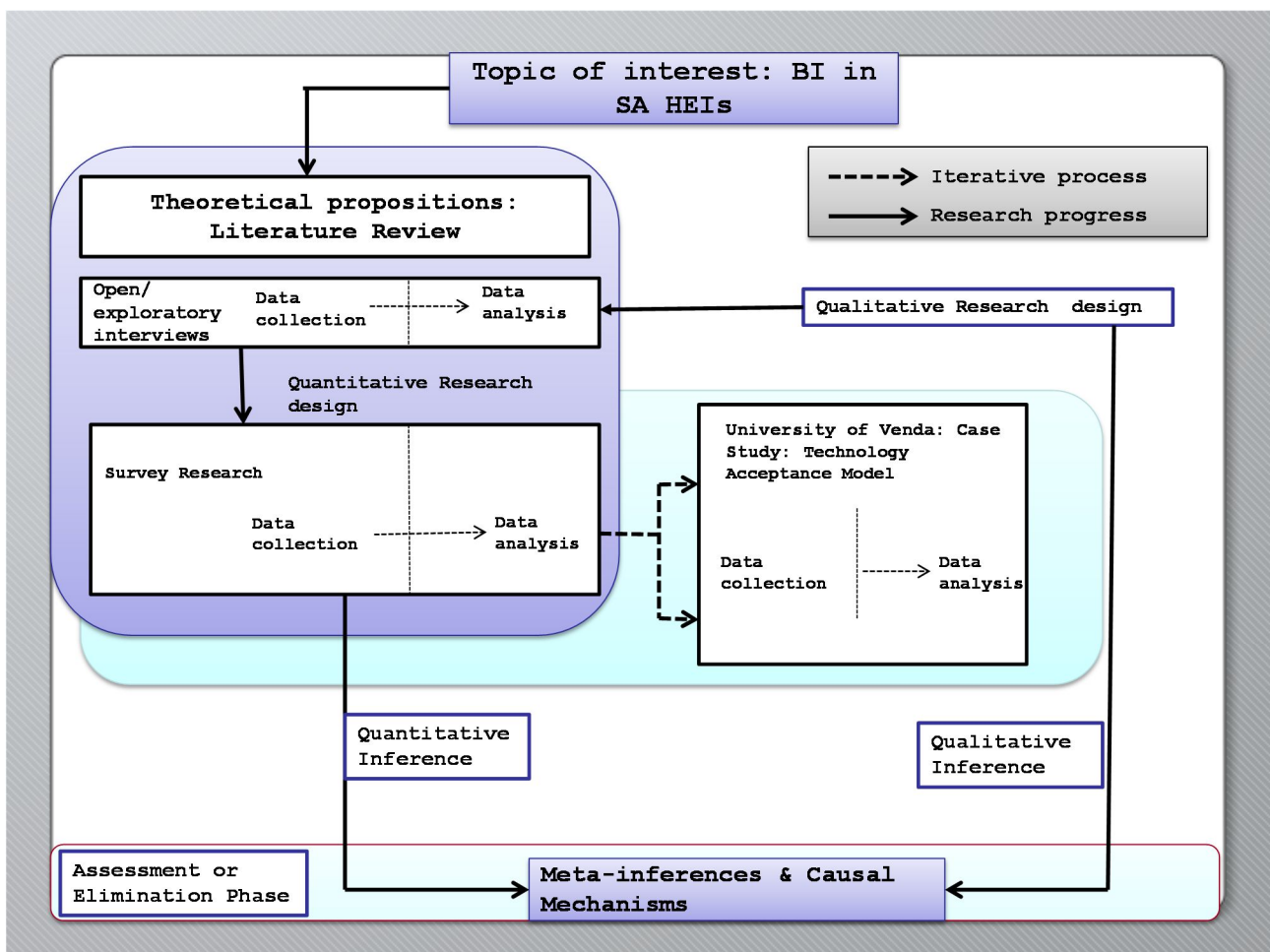


Figure 3.1: Mixed Methods Research Design

The business intelligence surveys that this researcher deployed, were theory driven, where this researcher looked at various components of BI systems within the broader higher education system. In order to consolidate, the results of the BI survey, which was deployed in the South African higher education sector, this researcher used Gregor & Hevner (2013) design science research approach. The design science research approach assisted in coming up with the CABIF as mentioned earlier. The CABIF was evaluated at using an extended and customised technology acceptance model survey based on the principles of (Davis, 1989; Davis et al., 1989; Davis & Olson, 1985). Figure 3.1 conceptualise the research design, and the mixed research methodology used and solicited during the research.

3.12.1 Reasons for choosing Mixed Research Methods Design

In a study that was intended to bridge the qualitative and quantitative divide in information systems research Venkatesh et al. (2013) argued that, mixed methods research can help develop rich insights into various phenomena of interest, that cannot be fully understood using only a quantitative or qualitative methods. Venkatesh et al. (2013), also argued that there have been repeated calls for such work which uses mixed methods research, but there is still a dearth of mixed methods research in information systems. Having shown that there have been few research studies in the IS domain that used mixed methods research this researcher chose it because of the following reasons:

i) **Deficit in research publications for mixed methods research**

Less than 5 percent of IS research publications between 2001 and 2007 in six major IS journals that were identified by the Senior Scholars Basket of Journals employed mixed methods research (Venkatesh et al., 2013). The decision this researcher took to conduct a mixed methods research hinged on the multiple research questions that this researcher wanted to answer, the research objectives and the context of the research.

ii) **Overcoming the cognitive and practical barriers**

Mixed methods research can assist in overcoming the cognitive and practical barriers, and can be taken without paying attention to the paradigmatic or cultural incommensurability. Mixed methods research, can address both exploratory and confirmatory research questions in the same research study (Venkatesh et al., 2013).

iii) **Provision of stronger inferences**

Mixed methods research can provide stronger inferences than a single method or worldview (Sykes, Venkatesh, & Rai, 2011; Teddlie & Tashakkori, 2009; Venkatesh, Bala, & Sykes, 2010). Mixed methods research can leverage the corresponding strengths and non-overlapping weaknesses of qualitative and quantitative methods, and bargain countless perceptions on a phenomenon that each of these methods independently cannot provide (Venkatesh et al., 2013).

3.12.1.1 Purposes of Using Mixed Research Methods in an Inquiry

Mixed methods research affords a myriad of prospects for a greater hodgepodge of divergent and/or complementary views. The employment of mixed research methods has to serve certain identified purposes. This researcher agrees with the following purposes of mixed methods research given by Venkatesh et al. (2013), and these also contributed to the reasons why this researcher chose mixed methods research design:

- **Complementarity:** mixed methods are used in order to gain complementary views about the same phenomena or relationships.
- **Completeness:** mixed methods designs are used to make sure a complete picture of a phenomenon is obtained.
- **Developmental:** questions from one strand emerge from the inferences of a previous one (sequential mixed methods), or one strand provides hypotheses to be tested in the next one.
- **Expansion:** mixed methods are used in order to explain or expand upon the understanding obtained in previous strand of a study.
- **Corroboration/confirmation:** mixed methods are used in order to assess the credibility on inferences obtained from one approach
- **Compensation:** mixed methods enable to compensate for the weaknesses of one approach by using the other
- **Diversity:** mixed methods are used with hope of obtaining divergent views of the same phenomenon.

Although there have been cumulative requests for going beyond the magniloquence of the variances among epistemologies and methodologies to develop a disciplined methodological pluralism in information systems research, there is restricted research that has engaged in methodological pluralism in the information systems literature (Sarker et al.,

2013; Venkatesh et al., 2013; Zachariadis et al., 2013). As Venkatesh et al. (2013) argued the current state of methodological multiplicity in information systems (IS) research is heartening, but there is a deficiency of research in IS that employs a mixed methods approach i.e., use of both qualitative and quantitative methods in a distinct research inquiry. Mixed methods research can provide a handful of advantages, but as mentioned earlier, in this study, this researcher primarily considered the research questions, research objectives and the context of the research. This researcher does recognize the fact that, there is myriad research methods that can be deployed in a mixed methods research inquiry, and, in the next section the research methods deployed to answer the research questions are documented.

3.13 Research Methods

This researcher distinguished mixed methods research and multimethod research, as this researcher gathered from literature that these are the two major types of multiple methods research. According to Venkatesh et al. (2013) and Teddlie & Tashakkori (2009), multimethod research, occurs when researchers employ two or more research methods, but may restrict the research to a single worldview. In contrast mixed methods research is more in line with methodology combination, which basically need several worldviews, that is, a mixture of qualitative and quantitative research methods (Venkatesh et al., 2013). In a study to bridge the qualitative-quantitative divide, and establishing the guidelines for conducting mixed methods research in IS, Venkatesh et al. (2013), argued that quantitative and qualitative research methods can be either used concurrently or sequentially in the same inquiry. When quantitative and qualitative research methods are used concurrently, they are independent of each other, but, when they are used sequentially, findings from one approach inform the other, in order to understand a phenomenon of interest.

In this study this researcher conducted a sequential mixed methods research study in order to understand the theoretical and practical underpinnings of BI in South African higher education. The results from the mixed methods research study, informed the direction for the design science research which this researcher employed to develop the CABIF. The CABIF was then deployed as a case study at the University of Venda, to put into practice the facets of CABIF and measure the user acceptance of the BI tools deployed. As can be seen in the next section the first phase of the study employed exploratory qualitative/quantitative studies to unearth the factors related to the practical and theoretical status of business intelligence systems in South African higher education. The second

phase used the results from the first phase and deployed design science research to come up with a context-aware business intelligence for the South African higher education sector. Subsequently, there was a series of evaluative/confirmatory quantitative studies to test the usage and adoption of the theoretical underpinnings of CABIF at the University of Venda. This researcher was of the assumption that, using mixed methods research in this study, would enable to provide an opportunity for a greater assortment of divergent and/or complementary views in terms of BI within the SAHEIs.

3.13.1 Exploratory Study of BI in South African HEIs

In their study regarding qualitative studies in information systems Sarker et al. (2013), defined exploratory research as a research that is conducted for a problem that has not been clearly defined. This researcher chose exploratory studies in the first phase of the research study, because it occurred this researcher did not know enough to make conceptual distinctions or posit the theoretical or practical underpinnings for BI within the SAHEIs. The main aim of choosing exploratory research was also to identify the boundaries of the environment in which the problems, opportunities, contexts or situations of business intelligence were likely to reside within the South Africa higher sector, and to identify the salient BI factors or variables that might be found there and be of relevance to the research. The exploratory study was both quantitative and qualitative in nature, in form of survey research and was targeted to provide answers to the first research question.

In this study, this researcher needed to understand the current BI frameworks or conceptual frameworks currently deployed in the 26 South African public higher education institutions. The research questions that were addressing this pursuit are: *What are the conceptual foundations of the business intelligence frameworks currently used in the South African Public Higher Education Institutions, and are these technological entities theoretically and practically contextualised?* These research questions came from the broader research aim of trying to scan, explore and get theoretical and practical information about the business intelligence solutions and frameworks currently used in the South African higher education sector. The research questions required a classification of the scientific knowledge relating to current business intelligence applications and contextualize them in relation to theories and practices of IS research. For this purpose, this researcher developed a survey that had a wide range of probing questions to information technology practitioners, business intelligence professionals, strategic management support and related professionals within

the higher education sector. This researcher wants to emphasize the fact that this research question was meant to technical people with ICT skills, data analytics skills, institutional research skills, organizational intelligence skills and information systems related skills.

The survey first needed to know if an institution had a BI solution, and if yes, the solution was then stated. Some of the questions were elaborated based on the 5-point Likert scale and needed to know the importance and satisfaction of these BI solutions based on business and Technology alignment; Business intelligence; Organizational and Behavioural Strategy in the BI implementation and Technology Strategies within the university. The survey went further to probe if the university had thought of alternative solutions to their current BI systems and if the BI solution had an integrated theoretical framework. A further question needed the respondents to elaborate further information concerning the theoretical framework and MIS allowed them to deal with personalised data requests or specific reports.

3.13.1.1 Design of the Fieldwork in the SAHEIs

Designing the survey regarding business intelligence systems in the South African higher education was surprisingly a complex process. This researcher needed to do a lot of background research before designing the survey. This researcher relied initially on the literature findings, and then determined how the survey would look like when finalized. The type of the data that this researcher would have gathered, drove the analysis that this researcher could do. This researcher took time to do some upfront work to design the survey, because this researcher knew that once the survey has been deployed, it could not be taken back, questions could not be changed nor the response options. Besides the wording of the survey questions and the response options, this researcher considered other factors in order to have a quality survey that would improve the overall results. Among the factors considered during the design of the survey included the survey flow, and organization with the ultimate aim to improve both the response rates and the quality of the data gathered. In designing the survey this researcher also considered the levels of the data, as these would drive the analysis that was able to be done.

a) Levels of Data

This researcher considered that some statistical analysis needed to be done on the data collected during the research, therefore this researcher carefully studied the rules regarding

the four levels of data, that is, **nominal**, **ordinal**, **interval** and **ratio**. According to (Sarker et al., 2013),

- i) **Nominal data** are referred to as "**name**" in other words, the numbers have no intrinsic value and there's no particular order to the data. These are often called "**categorical**" in that they help to create categories or groupings. For example, men/women, or resident/commuter, or full-time/part-time.
- ii) **Ordinal data** have a particular order, but the intervals between the items are not the same or the intervals are not "**measured**." For example, "never/once/five times/10 times/>10 times" or "0 credits; 5 credits; 10 credits; >10 credits." Nominal and ordinal cannot compute a rational mean (average) and are sometimes referred to as "discrete" data. About all one can do for analysis is to count them or do frequencies, since they do not compute a rational mean, one can only use chi-square or other types of non-parametric analysis.
- iii) **Interval data** are a rational measurement. In other words, the interval between each item is the same distance or unit of measure. Interval data have the characteristic of a measured zero. In other words, the zero is a value on the number line; therefore, negative values are possible. The classic example is temperature (degrees F) or bank balances. Social scientists typically classify true Likert scales as interval, with the option 3 ("neither agree nor disagree") as the zero point and the negatives and positives on either side. A true Likert scale is balanced with as many positive values and negative values and has a middle "neutral" option. We can derive a rational mean from these data (for example, a 4.5 on a 1-5 satisfaction scale is understood to be 'pretty happy'). While it is not a measured scale in the classical sense, there's plenty of empirical evidence that one researcher's "4-satisfied" is very similar to another researcher's "4-satisfied" and less than someone else's "5-very satisfied", (Sarker et al., 2013).
- iv) **Ratio** data have the properties of interval data, except the zero means "absence of." In other words, a negative value is not possible. These are true measured values like height, weight, age, or distance. The type of data can be a ratio or fraction. Since interval and ratio data can both compute a rational mean, they are considered "continuous" data (or on a continuum or measurement). Since they can compute a rational mean, they can also use the parametric tests. This researcher documented extensively the survey processes based on the recommendations from Sarker et al. (2013).

b) Documenting the Survey Process

Documenting the survey process is often an underestimated process but it is also an important component of the survey development process. This researcher developed a codebook for the survey on business intelligence deployed in the South African public higher education institutions. The codebook provided written, clear documentation of the processes for the survey. The main goal was to document every step so that if someone else could replicate the survey process exactly; and to provide documentation of the survey structure. The codebook also included the definitions and layout required for the appropriate data analysis, and to provide the purposes of the research questions. The details of the codebook and the documentation of the survey process are given in Appendices A1 to A3. The key components of the codebook are the Journal of activities related to the survey, an explanation of the survey process, and the data dictionary.

c) Journal of Activities

The journal of activities, had details of the survey's time frame. In the explanation of the survey process, this researcher describes the target audience and how the respondents were chosen. This researcher also explained how the survey was disseminated, and in this study it was administered electronically, telephonically and face-to-face. The survey process was informed by the research purpose, the research question, and the objectives of the study. The web survey which was developed in the Lime Survey software, was used because it was easy to deploy, and the costs were relative low, (see Appendix F2). In order to have high response rate, this researcher made follow-up surveys telephonically and face-to-face interviews. The respondents only came from the institutions that gave this researcher the ethical clearances to carry out the research (see Appendix F1). In the journal of activities this researcher was able to track the administrative process, which encompasses the cover letter and invitation to the survey (See Appendix F2), the dates of the follow-ups, and the rationale for the research.

d) Survey Administration

This researcher also recorded the response rates, in order to use these in the report of the findings. The mishaps that occurred along the way were also recorded and the lessons learnt from each survey administration, and any ideas for changes, were also recorded. However, in this study no item in the survey was changed, but only to augment the survey

deployment process. The data dictionary in the codebook holds the detailed descriptions of every variable in the survey. The key components described in the data dictionary were the variable name which was a short, alpha-numeric character, the variable label, which was an item wording, the response option coding, type of data/variable, and special instructions like reverse coding. We created the specific variable names and response codes after the survey items were created and ordered, but before the survey was disseminated. This researcher refined the codebook whilst the survey was already being administered, as this researcher could look at the responses in the Lime Survey database and analyse how the data was captured in the database. This researcher was of the notion that a good survey design results in good research outcomes that can be used to inform the responses to the research questions.

e) Structure of the Business Intelligence Survey

This researcher clustered survey items into five clusters. The clusters were, South African public universities, business and technology alignment, organizational and behavioural strategies, technology strategies and the business intelligence domain. The whole survey had 37 items, with South African public universities (**one question**), business and technology alignment (**eight questions**), organizational and behavioural strategies (**ten questions**), technology strategies (**nine questions**) and business intelligence domain (**four questions**), **one question** on methodology, **one question** on satisfaction with current BI system, and the **last question** was an open-ended question. Amongst the 37 questions in the survey, 34 questions were having dual evaluation response options, where respondents have to value how satisfied and how important each survey item was to them. One survey item needed a frequency response, as it was measuring how often the respondents were engaged in developing BI reports. One survey items were an open-ended question, and the purpose was to ask the respondents to provide data that could not otherwise be captured using the scaled or forced response items. Finally, one question needed the respondents to choose the university they were working for during the time for survey administration.

f) Scaled Survey Responses

Scaled responses were used, as continuum was followed with anchor points at each end of the scale. This researcher designed 35 questions based on the Renis Likert's, dual six-point Likert scale, based on how the respondents have to value their satisfaction and importance

of each survey item. The Likert scale allowed this researcher to measure both the direction and the intensity of the survey responses. The dual scale responses included “*extremely unsatisfied/ very unsatisfied/ unsatisfied/satisfied/very satisfied /extremely satisfied*” and “*not important/not so important/slightly important/important/very important/extremely important*”. This researcher preferred this method as there was no ambiguity about each item on the scale. A middle option was deliberately eliminated and the ambivalence option in the dual scaled responses because, this researcher wanted to force the respondents to make a choice even if the choice was weak, and with this this researcher thought that would give a window for understanding business intelligence systems in the South African higher education. Table 3.2 shows the journal of activities regarding the survey.

Research Question	What are the conceptual foundations of the business intelligence frameworks currently used in the South African Public Higher Education Institutions, and are these technological entities theoretically and practically contextualised?			
Type of Survey	Anonymous		Schedule	
Contact	Goals		Electronic	Telephonic
1	Pre-notice	Stating when the Survey will be e-mailed, and what is it all about, and the importance of the responses	Sep-14	Nov-14
2	Pilot Study	We needed to know that the survey was ready at the prime time. The survey was pre-test with 47 participants from the South African higher education.	Nov-14	Jan-15
3	Invitation	Survey distribution by e-mail with link to the web survey, with detailed cover letter, and it was 20-30 Minutes to complete	Jan-15	Mar-15
4	First follow-up	Follow-up reminder via a friendly e-mail, and telephonic conversations to the gatekeepers and focal persons at each institution	Apr-15	Apr-15
5	Replacement Survey	Provide another copy of the survey with another differently worded cover letter. Get ethical clearance from institutions that require that procedure as means of doing research with their staff	May-15	June-15
6	Final Contact	Use a different mode of survey delivery, where possible	Aug-15	Nov-15
7	Data collection ends	Online survey is taken down	Dec-15	Dec-15

Table 3.2: Journal of Research Activities

3.13.1.2 Population and Sample from the SAHEIs

The population of interest in the research was composed of information technology champions at various universities, business intelligence specialists, Management information specialists, and institutional researchers and data scientists. The participation in the research was voluntary and individual participants had to acknowledge their participation through a consent form and a covering letter. In some instances, the consent form was not

necessary as the survey was anonymous. At the University of Venda all levels of management were considered as the sample and population ($N=n$), and it was considered sufficient if half of these participants responded to the survey.

a) Sample and Population Selection

The sample which was also the population was selected in such a way that it did not cause them to be systematically different from the underlying population. A non-probability, convenience sampling was done in this case because for participants to respond to the survey items they needed to have a sound background in information systems, particularly decision support systems. The survey administered required the participants to have some knowledge or skills in information systems development methodology, management information systems, institutional research, business intelligence, data analytics and a good understanding of business and information technology alignment principles. Depending on the organizational structure of the institution, participants were coming from Information and Communication Technology Units, Institutional Research Units, Data Management Units, Management Information Units and Institutional Planning Units.

In this research, this researcher was very wary about the selection bias, as this could result into misleading conclusions. This researcher gave a careful thought on selecting the population and sample and also calculated the sampling error based on the number of respondents from the survey.

3.13.1.3 Ethical Considerations

The research study referred to the direct participation and involvement of staff from different public universities in South Africa, through responding to an online survey, thus creating an obligation to protect their rights and interests and of all the universities. The research study abided by each institution's Policy on Research Ethics. This researcher applied for ethics approval from each institution and the study was envisaged as a low risk, to the participants. The only risk was the inconvenience to human participants in taking their time to complete the survey. The survey items did not even entice the research participants into a violent behaviour and they were also not distasteful. The research did not damage the participants' job prospects as no confidential data about them became known to others because of the study.

This research did not collect any personal data, or divulge the names of the institutions in the final study report. The survey was anonymous and only included one survey item identifying the institution the respondent was coming from. In the final data analysis, this item was not reported, as the main aim of the survey was to collate the principal factors that drive the theories and practice of business intelligence in the SAHEIs. In most cases this researcher needed to submit the research proposal of this study for approval by the Research and Ethics Committee for each institution. Within South Africa, this researcher was also obliged to follow the principles advocated for in the Protection of Personal Information Act, 4 of 2013 (POPI). This researcher respected the autonomy of the participants to make their own decisions, and no penalties were charged when they decided to withdraw or participate in the survey. This researcher got ethical clearance approvals from 17 of the 26 public universities in South Africa.

3.13.1.4 Piloting the Business Intelligence Survey

The Business Intelligence Survey in the South African Higher education was pre-tested with 47 participants from the population and sample mentioned earlier. The pre-testing or piloting the survey was done to measure if this researcher was asking the right questions, to judge whether the target population understood the survey questions, to understand if the planned survey methods would work and to validate if the survey would collect accurate and usable data. The pre-testing phase assisted this researcher in making corrections to the survey instrument and methods, in order to maximize the quality of the data and to assure the success of the survey. In this study before this researcher piloted the survey, this researcher sought for expert feedback regarding the survey items from a group of people.

The experts in business intelligence looked at the content areas addressed by the survey in order to verify the questions, as they were capturing a range of BI issues and information. The full range of issues addressed by the survey were addressed earlier, but this researcher wanted these experts to do content validity. The subject matter experts revealed that there were some double-barrelled questions and advised in reducing the number of survey items to limit the response time within 15 to 20 minutes. The experts also mentioned that this researcher should guard against survey response or research fatigue from the target population. This researcher then e-mailed the survey to experts in research particularly experts in survey research and design, and those with extensive experience in conducting surveys. The survey experts were expected to spot problem questions, jargon, question

ordering, faulty response options or confusing question structures that might compromise the quality of the data collected. The survey research design experts also assisted this researcher in identifying questions that were not presenting clear pathways of being aligned to the data analysis framework.

Description of the Pilot Survey

When the survey instrument was finalized and was pre-tested by experts and individuals from the population, this researcher then conducted a small pilot study. The pilot study was basically a test run of the procedures and the survey questions to discover problems before the main study had begun. This researcher chose 47 participants from the 17 institutions who had given this researcher the ethical clearance approvals to carry out the research at the institutions. The 47 participants allowed this researcher to be able to roughly estimate the response rate and the general patterns of the response rate. This researcher administered the pilot study in the same research setting or context as the full survey. The instructions for completing the survey replicated the intended methods as closest as possible. During the piloting phase, this researcher also tested the processes by which were used to distribute the survey and data collection. The analysis of the data collected from the pilot study are reported in the next data analysis chapter (Chapter 4).

The pilot study revealed that surveys are a tricky business, and one should not do it entirely alone. Pre-testing the survey could save time and prevent errors that can badly compromise the research results. A full data analysis and presentation of the results of the survey are documented in Chapter 4. The preliminary results from the pilot study concurred with Hevner & Chatterjee (2010) who argued that, information systems are implemented within an organization for the purpose of improving the effectiveness and efficiency of that organization. Hevner & Chatterjee (2010) went further to argue that, the usefulness of the information system and features of the organization, its work systems, its people, and its development and implementation methodologies together determine the extent to which that purpose is achieved.

This researcher also concurred with Hevner & Chatterjee (2010) who stated that *“It is incumbent upon researchers in the Information Systems (IS) discipline to further knowledge that aids in the productive application of information technology to human organizations and their management and to develop and communicate knowledge concerning both the management of information technology and the use of information technology for managerial*

and organizational purposes.” The deployment of the survey and face-to-face interviews allowed this researcher to come up with business intelligence theoretical concepts pertinent in the SAHEIs. These theoretical concepts formed the basis for the design science research which this researcher used to develop the context-aware business intelligence framework for the South African higher education sector.

3.13.2 Design Science Research for CABIF

Information systems (IS) are composed of inherently mutable and adaptable hardware, software, and human interfaces provide many unique and challenging design problems that call for new and creative ideas (Hevner & Chatterjee, 2010). In a study about the theory and practice of design science in information system, Hevner & Chatterjee (2010) stated that the design science research paradigm is extremely appropriate to information systems (IS) research because it unswervingly addresses two of the crucial matters of the discipline: the principal, although contentious, role of the IT artefact in IS research and the apparent lack of professional relevance of IS research. Design science, supports a practical research paradigm, which calls for the establishment of ground-breaking artefacts to solve real-world problems (Hevner & Chatterjee, 2010). Thus, design science research combines an emphasis on the IT artefact with a high priority on relevance in the application domain.

a) Development of CABIF

In this research, the development of CABIF was guided by the paradigm of problem solving which dealt with presenting a business intelligence framework that consisted of defined constructs, theories, models, methods and instantiations suitable for the South African Higher education sector. This was achieved by thoroughly examining the problem domain, the maturity of business intelligence solutions and of the solution spaces in the South African higher education sector as advocated by (Goes, 2014; Hevner, March, Park, & Ram, 2004). This researcher applied design science research to the following research question: *What Context-aware business intelligence framework is suitable for the South African public higher education sector, and why?* As shown in Figure 3, this researcher applied design science research techniques to this research question as theorised and publicised by (Goes, 2014; Gregor & Hevner, 2013; Hevner et al., 2004). Design science research enabled the researcher to derive common business intelligence entities within the higher education sector in South Africa, then developed and bring forth a contextualised business intelligence framework for the sector. The research that helped to build the CABIF is actually grounded

principally on the theoretical underpinnings behind business intelligence systems, the common business intelligence attributes in the South African higher education core business, context-awareness and information systems. In pursuit of answering this research question, this researcher included studying documentation related to management information systems from the SAHEIs, including their statutory obligations. The data collected during the process of answering the first research question did provide a conceptual insight on how a context-aware business intelligence framework for the sector could be developed. The roles of knowledge in design research in information systems also provided this researcher with a research conceptual framework for the design and development of the CABIF and this researcher followed the theoretical underpinnings developed by Gregor and Hevner (2013).

b) The Design Artefact

In a study about design science research Goes (2014) cited Gregor and Hevner (2014), and indicated that the artefact itself will also encompass and will produce knowledge which might be in the form of *constructs, models, methods and instantiations*, that may or may not lead to design theory. In this research the artefact developed through the deployment of design science research techniques, is the Context-aware Business Intelligence Framework (CABIF) for South African Higher Education. This researcher also concurred with the fact that the artefact, in this case the CABIF when deployed and analysed could actually contribute to the descriptive knowledge and can even create new knowledge (Goes, 2014; Gregor & Hevner, 2013; Hevner et al., 2004).

It is important to note that in design science research the main concern is not about testing or creating new theories, even though the constructs and methods can lead to this process (Goes, 2014; Gregor & Hevner, 2013; Hevner et al., 2004). Goes (2014) argued that the main objective of design science research is to create knowledge from meaningful solutions which can survive arduous authentications through proof of concept, proof of use and proof of value. There is no obligation for design science research to have an explicit and mandatory tie to theory, and it is valuable that this fallacy be evaded. The adaptation to the roles of knowledge in DSR advocated for by Gregor and Hevner (2013) is represented in Figure 3.2. This researcher used this adaptation in the development of CABIF. This researcher pursued research rigour using the DSR techniques by employing concrete scientific methods to develop the CABIF and the deployment and validation thereafter.

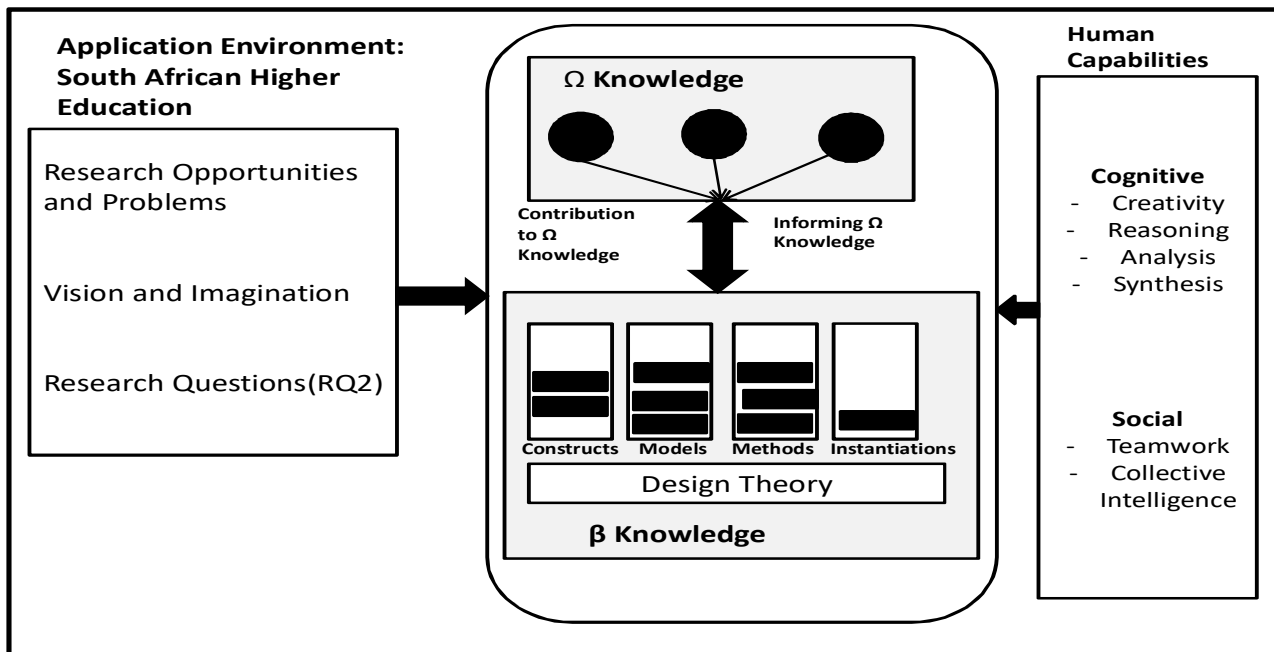


Figure 3.2: The Roles of Knowledge in Design Science Research (Gregor & Hevner, 2013)

What steps did this researcher followed to develop CABIF using DSR, if theory is not the premise? As mentioned earlier, this researcher followed the schema proposed by Gregor and Hevner (2013). The general recipe to develop an artefact through DSR as publicised by Gregor and Hevner (2013) follows the following steps:

- Introduction with precise articulation of purpose and scope of the artefact.*
- Literature review section with relevant descriptive knowledge and prior prescriptive knowledge.*
- Method section where research rigour is fundamental.*
- Artefact description.*
- Evaluation*
- Discussion and Conclusions (Goes, 2014, p. vi)*

Hevner & Chatterjee (2010) argued that a custom of design science research in the IS field has been sluggish to amalgamate. Research in IS has been dominated by studies of the impacts of IT artefacts on organizations, teams, and individuals (Gregor & Hevner, 2013; Hevner & Chatterjee, 2010; Hevner et al., 2004). Design research was considered the domain of more technical disciplines such as computer science and electrical engineering. This researcher will discuss how the recipe for design science research was employed in Chapter 4, where the data collection, analysis and presentation of the results is discussed. In this research, this researcher made sure to validate and evaluate the CABIF in a particular South African higher education context.

3.13.3 Deployment of CABIF the University of Venda

This researcher designed this research in such a way that the developed CABIF, would be linked to a chosen business intelligence solution at the University of Venda. This researcher thought that the solution would include, looking at the different contexts covered in the CABIF, and deploy these within the University of Venda. The research at the University of Venda culminated by deploying a technology acceptance survey in order to measure the perceived usefulness, ease of use, attitudes towards use, and the intention to use the deployed BI solution and tools. At the University of Venda, the research included the following activities:

- a) Enrolment studies which examined the number of students enrolling for a given academic period and tracked by year. The enrolment patterns associated with students from a specific program or demographic group fell within these studies.
- b) The persistence-retention- attrition studies. Persistence studies enabled to examine the flow of the students through the institution. First-time entering students must be identified and these were tracked through various semesters to determine how many of the original group remained in the system until the last reporting semester. This allowed for UNIVEN to discover what was happening naturally in the system without any intervention. This researcher thought this data would then be used as the baseline data, for determining the impact of retention-enhancing programs or activities. Attrition studies involved stop-outs and drop-outs which refers to the tendency of students to withdraw from a module or a qualification. The students referred to as stop-outs withdraw from a qualification or module at a certain point within an academic calendar and return to the same module or qualification later in the future. Those students regarded as drop-outs will never return to a module or qualification soon. These studies might be an indication of which modules or qualifications students are having difficulties to complete. The attrition studies would also inform areas that need more resources and they are also an indication of determining student engagement within UNIVEN.
- c) Longitudinal studies or the examination of a group of students over a period of time using characteristics notable to the University of Venda. These studies included an examination of time to complete degrees, and student success rates over a period of time.
- d) forecasting government block grants
- e) determining viability of academic programs

- f) Developing structured query language reports and cube reports for decision-making.
- g) Using the technology acceptance model to study the user adoption and acceptance of the implemented context-aware business intelligence framework at the University of Venda.

In study concerning survey constructs measurement and validation procedures in MIS and behavioural research, MacKenzie, Podsakoff, & Podsakoff (2011), stated that that many of the scale development procedures encouraged in the literature are restricted by the fact that they *“(1) fail to adequately discuss how to develop appropriate conceptual definitions of the focal construct, (2) often fail to properly specify the measurement model that relates the latent construct to its indicators, and (3) underutilize techniques that provide evidence that the set of items used to represent the focal construct actually measures what it purports to measure”*. Thus, this researcher transcended from the first research question, to reach to the third research question in order to develop comprehensive set of measures for the technology acceptance survey at the University of Venda. This researcher acknowledges the fact that, despite the fact that validating the measures of constructs is critical to the construction of collective knowledge in MIS and the behavioural sciences, the practice of scale development and authentication remains to a thought-provoking endeavour. The measurement of the user acceptance of the BI tools and solutions developed and deployed at the University of Venda, were based on the theoretical value for better measurements to predict information systems usage published by Davis (1989).

3.13.3.1 Technology Acceptance Survey at the University of Venda

Valid measurement scales for forecasting user acceptance of using computing systems are inherently in short supply (Davis, 1989; Davis et al., 1989; Hess, McNab, & Basoglu, 2014). In this research, this researcher attempted to gain a better understanding of the adoption of the new management information systems services, in this case business intelligence in South African Higher Education. The technology acceptance model according to Davis (1989) was used not the only as a theory that can be used to explore the user acceptance of technology and its usage, but to understand the perceived value of CABIF. Several theories that are related to user acceptance and usage of information technology exist, such as the Theory of Planned behaviour (Lim and Dubinsky, 2005); the Theory of Reasoned Action (Komiak and Benbasat, 2006) and the diffusion theory (Bhatti, 2007) among others. The technology acceptance model according to Kleesuwana, Mitathab, Yupapinc, &

Piyatamrong (2010), presents powerful empirical and theoretical advantages in that it has emerged as a dominant and parsimonious model that represents experiences of technology usage through beliefs related to the *perceived usefulness* and the *perceived ease of use* of a technology.

a) Technology Acceptance Model Design

As mentioned earlier, this research intended to gain an understanding of user adoption of the context-aware business intelligence based technologies at the University of Venda. The technology acceptance studies, TAM, deployed at UNIVEN were concerned with determining consciously intended behaviours of users against the BI tools and technologies. This researcher thought that TAM would provide an explanation to the determinants of the BI adoption and acceptance that are general, but capable of explaining the behavioural patterns across a wide range of users at UNIVEN. The theory of reasoned action (TRA), according to Straub (2012) which is apprehensive with shaping deliberately individual projected behaviours forms the basis for TAM (Davis, Bagozzi and Warshaw, 1989) and TRA has its foundations in the social psychology domain. The TAM designed by the researcher for the case study at Univen is illustrated in Figure 3.3.

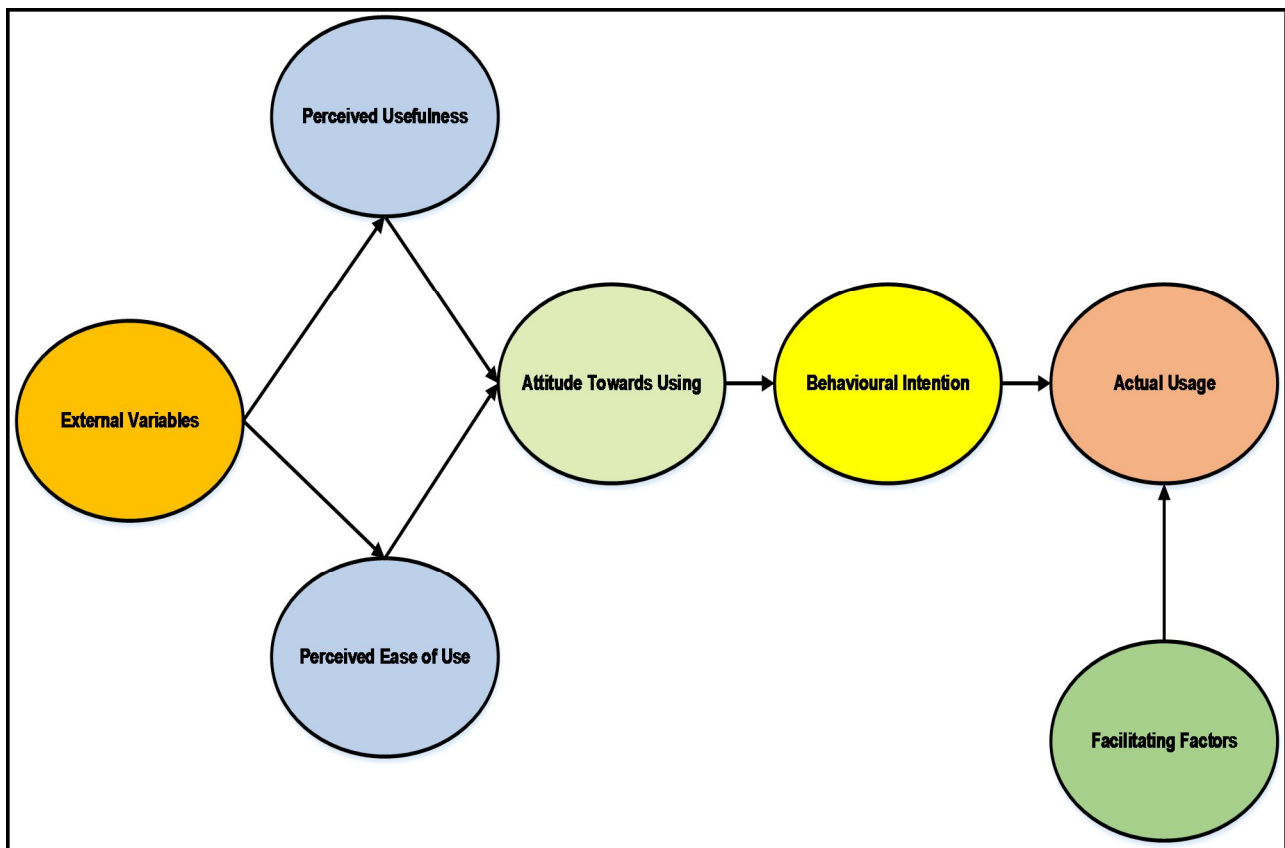


Figure 3.3: Technology Acceptance Model

b) Research Value of the Technology Acceptance Model

The technology acceptance model allows for establishing the relationships between the various variables engraved in the model. The establishment of such relationships between variables prompted for a correlational study in the first instance. The independent variables were the external variables [age, experience], [facilitating factors], [perceived ease of use] [attitude towards using] and [perceived usefulness]. The dependent variables are the [perceived usefulness] and the [actual usage]. It is also important to note that at one stage the variable might be independent and at another stage it will be a dependent variable. The hypotheses confirmatory studies and tests were valuable in distinguishing between the independent and dependent variables. An online technology acceptance model survey was deployed to the research participants at university of Venda. The full design of the technology acceptance survey, is shown in the appendices, and the detailed analysis of the survey is in Chapter 4.

c) Constructs Domain of the Technology Acceptance Model

When this researcher designed the constructs for the technology acceptance survey deployed at the University of Venda, the validation or scale development process began with a clear articulation of the constructs domain. The constructs domains for the survey, were as follows: Perceived Ease of Use (5 questions); Perceived Usefulness (5 questions); Attitude Towards Using (5 questions); Intentions to Use (5 questions); Facilitating Factors (4 questions); Actual Usage (3 questions) with experience of using computing systems and age of the users having one question each. In total of 29 Survey items took 15 to 20 minutes in pre-test runs for users to complete the survey. The scaled responses were defined on all levels of the six-point classic Likert scale with the following response options: “*strongly disagree / disagree / neither agree or disagree /slightly agree / agree/strongly agree*”.

d) Journal of Activities for Technology Acceptance Model

Table 3.3 illustrates the Journal of activities of the TAM survey. The scale clearly defined the anchor and all points in between, to reduce ambiguity about what each point on the scale represents. Two questions related to the actual usage of the BI system, had frequency responses, as the researcher wanted to know how often the users were engaged with the BI system. The other two question related to age and experience in using computing systems had closed choices, and the choices were mutually exclusive and exhaustive. The codebook, and the variable explanations are shown in the Appendices B1 and B2.

Research Question	What is the end-user's perceived adoption and acceptance of the implemented business intelligence solution at the University of Venda?			
Type of Survey	Anonymous		Schedule	
Contact	Goals		Electronic	Telephonic/Face to face
1	Pre-notice	Stating when the Survey will be e-mailed, and what is all about, and the importance of the responses	Jan-15	Mar-15
2	Invitation	Survey distribution by e-mail with link to the web survey, with detailed cover letter, and it should be 15 - 20 Minutes	Jan-15	Mar-15
3	First follow-up	Follow-up reminder via a friendly e-mail	Apr-15	Apr-15
4	Replacement Survey	Provide another copy of the survey with another differently worded cover letter. Try to achieve a high response rate from the staff at the University of Venda	May-15	May-15
5	Final Contact	Use a different mode of survey delivery, where possible	Jul-15	Nov-15
6	Data collection ends	Online survey is taken down	Dec-15	Dec-15

Table 3.3: Journal for Technology Acceptance Survey at University of Venda

3.14 Data Analysis Preparation

The survey instruments deployed in the South African higher education needed to be valid in terms of content, and the questions were drawn from representative concepts of the BI domain. The research included mixed methods research techniques and these have implicit data analysis frameworks. The first quantitative research included piloting the BI survey in from 47 participants from the South African higher education sector.

3.14.1 The Pre-Test Data Analysis of the Business Intelligence Survey

The pilot data collected was subjected to exploratory factor analysis using the principal component analysis (PCA) with the anticipation of loading the satisfaction and importance of various business intelligence factors within the South African higher education sector. Initially PAC was set to extract as many factors on the user's perceived importance and satisfaction of the business intelligence domain within the higher education sector. The number of the needed BI components, or what this researcher deduced as the main business intelligence factors were determined by, the cumulative variance that was deduced from the scree-plot, and by the levels of the eigenvalue for each of the business intelligence factors.

It is important to point out that the data from the pre-test studies were subjected to exploratory factor analysis using the varimax rotation and the eigenvalue which were greater than one. The pilot data analysis allowed this researcher to choose a fixed number of BI factors, which were subjected to validity and reliability tests. The Cronbach's alpha-reliability tests were used to highlight the survey items that were problematic based on α value of each factor. The BI factors that were loading below 0.75 were subjected to a further investigation. Revisions of the survey instrument were based on the results of the pilot data analysis as well as using the feedback from the participants in the pilot study. A more detailed analysis of the pilot data is given in Chapter 4.

3.14.2 Data Analysis Strategy

The main study concerning BI systems in the South African Higher education sector, used the revised survey instrument that was corrected using the results of the pilot study. The data from this study, was further explored and confirmed using the PCA. The purpose of the PCA as a data reduction technique, was to restructure the business intelligence factors, into a smaller significant number, from a large proportion of factors. The way that PCA reduce the data is by measuring the variability within and co-variation across variables, statistically referred to as variance and co-variance respectively. The principal factor analysis works on interval/ratio data; hence the design of the survey instrument was mostly based on the interval data.

As an example, in PCA and exploratory factor analysis, let us say one intends to extract from a set of n data variables a reduced set of m variables, components or factors that accounts for most of the variance in the n variables. In short one needs to reduce the set of n data variables to a set of m underlying superordinate dimensions. These underlying factors are inferred from the correlations among n variables. Each factor or component is estimated as a weighted sum of the n variables. The j^{th} component is thus:

$F_j = W_{j1}X_1 + W_{j2}X_2 + \dots + W_{jn}X_n$; each of the n variables may be expressed as a linear combination of the k factors, $X_i = A_{i1}F_1 + A_{i2}F_2 + \dots + A_{im}F_m + U_i$; where U_i is the variance that is unique to the variable i , variance that cannot be explained by any of the common factors (Wuensch, 2012).

This researcher did an exploratory factor analysis through principal components analysis to decrease a set of 68 variables to 34 components or factors subsequent to additional analysis on those 15 components.

3.14.2.1 Rotation Methods for Principal Components Analysis

According to Wuensch (2012), there are two main rotation methods for factor analysis, these are “orthogonal” or “oblique”. The orthogonal rotation process assumes that the extracted factors are independent in the rotation process, and these maintains the same reference axis of the factors at 90°. Oblique rotation in the other hand allows for correlated factors instead of maintaining independence in the factors (Sarker et al., 2013; Wuensch, 2012). There are three major methods of orthogonal rotation and these are varimax, quartimax and equamax. Of these three varimax has achieved the most use in social and behavioural sciences, as it seems to give a clear separation of the factors (Hess et al., 2014; Sarker et al., 2013; Wuensch, 2012). This researcher used the varimax rotation to analyse the data.

3.14.2.2 Usage of Principal Components Analysis in the Research

In PCA each eigenvector has a corresponding eigenvalue which is a scalar value (Beaumont, 2012; Wuensch, 2012). The eigenvector relates to a direction, with the corresponding eigenvalue being a number that indicates how much variance there is in the data along that eigenvector or principal component (Beaumont, 2012; Sharma & Chandel, 2013; Wuensch, 2012). Exploratory factor analysis allowed this researcher to discover and summarize the patterns of inter-correlations among the variables drawn from the three BI dimensions proposed. The respondents’ *satisfaction* and the *importance* of components or factors of BI systems, were drawn from four different BI dimensions, i.e., Business and Technology Alignment; Business Intelligence; Organizational and Behavioural Strategies; Technology Strategies.

In each of the dimensions this researcher needed to group together components that were highly correlated with each other. This researcher did this grouping assuming that these correlations were influenced by the same underlying BI satisfaction or importance observed factors in the same dimension. Each of the four business intelligence dimensions was then operationalized by aggregating them into a linear grouping of the observable BI variables that contributed most comprehensively to the factor loadings. The other graphical tool that was used to evaluate the factor loadings was the scree plot.

3.14.2.3 Scree Test

Another device that is used for deciding on the number of components to retain is the scree test (Wuensch, 2012). The scree test is a plot with eigenvalues on the ordinate and component number on the abscissa (Beaumont, 2012; Wuensch, 2012). Wuensch described the scree as the rubble at the base of a sloping cliff. In a scree plot, scree is those components that are at the bottom of the sloping plot of eigenvalues versus component number. The scree plot is capable of providing a visual aid for deciding at what point including additional principal components no longer increases the amount of variance accounted for by a nontrivial amount (Beaumont, 2012; Wuensch, 2012). The other diagrammatic evaluation of the data was the rotated component space matrix.

3.14.2.4 Correlation Matrix

The data analysis framework included checking for unique factors in the data set. The unique variables as Wuensch (2012) called them, this researcher checked them through a correlation matrix. The size of the correlations of variables in the correlation matrix gave an indication of the factors to consider. The **Bartlett's test of sphericity**, was used as a statistic to test the null hypothesis. It indicated that although, no probability sampling was used, the respondents were drawn from a population in which the correlation matrix was an identity matrix. The variables that were not correlated to the other variables prior to the PCA, as suggested by Wuensch (2012), were deleted. The number of variables were reduced through this process. The correlation matrix, together with rotated component matrix were jointly evaluated with the table of communalities.

3.14.2.4 Communalities and Sampling Adequacy

The Communalities table, allowed this researcher to inspect the **Squared Multiple Correlation, R^2** , of each variable with all the other variables, as a means of also testing the uniqueness of each variable. This researcher drew up the Communalities values, using PCA in SPSS. The sampling adequacy was not an issue, because this researcher used a non-probabilistic sampling approach. However, this researcher extracted the **Kaiser's Measure of Sampling Adequacy**, as a means of verifying the reliability of the data. This researcher extracted the principal components by repackaging the values in the correlation matrix into eigenvalues of one or more. Another important aspect that was considered in the data analysis strategy was the integrity and accuracy of the data.

3.14.2.5 Data Accuracy

In order to determine the accuracy of the data, this researcher executed a pre-analysis of the data collected, in order to detect any irregularities or problems with the data. Prior to the main statistical analysis, this researcher performed a Pearson correlational analysis of the user's satisfaction and importance constructs of each of the BI factor in the survey. The results of the Pearson Correlation were quite profound, as they suggested that the user's satisfaction and importance of each of the BI factors were two distinct but related constructs. The results add to the validity of each BI domain, to be part of the envisaged CABIF.

3.14.2.6 Analysis Strategy of Textual Data

The survey instruments had textual questions that needed a qualitative data analysis, and the data from face-to-face interviews also needed qualitative data analysis. The textual data analysis approach that was used included, the identification of common thematic pattern and also working out the limitations, exceptions and variations present in the responses related to BI in SA higher education. This researcher then tried to generate tentative explanations for the patterns and seeing if they are present or absent in the BI settings or situations within the higher education sector. The way the textual data analysis is presented sounds as if it is an inevitable process that is lineal in nature and does not diverge. This researcher acknowledges that qualitative data analysis is dynamic, exciting and intellectually challenging, and is characterised by the iteration between theory generation and analysis, within the different types of textual analysis. In that case, it is easy to make false interpretations, judgements and conclusions about textual data.

3.14.2.7 Analysis Strategy for Technology Acceptance Data

The technology acceptance survey was subjected to correlational analysis and logistic regression analysis. This researcher found out that it was important to develop linear models to derive the users' adoption and acceptance of the BI technology and tools implemented at the University of Venda. The research question which dealt with the implementation of BI technology tools at University of Venda had one empirical research question. This question resulted from putting into practice the product of design science research, the CABIF, which is the design artefact. In Chapter 4, this researcher shows how the documentary evidence gathered from the South African higher education sector, and the results from the BI survey from the sector assisted in developing the CABIF. The meta-inferences that come out of the

quantitative, qualitative and design science strands of this mixed methods research study will be clearly elucidated.

3.15 Summary of the Research Design and Methodology

The chronology of the methodological paradigms, philosophies, strategies and approaches dealt with in this chapter reveals that, the comprehension of the object of research is of supreme importance. Research can either be quantitative or qualitative, but in this research the importance of methodological pluralism in IS research by deploying mixed methods research, is shown. The major goal of this research is to find ways of improving the design, development and implementation of BI systems within the SAHEIs. This researcher subscribes to Mavetera (2011), who argued that there should always be dependability between the research questions, the postulations made about the world view and how people understand it, and the methods used to tackle these research questions. An effort has been made to find a connection between these research tenets.

In this chapter, this researcher discussed most of the rudimentary philosophical foundations of IS research, hence using an umbrella term, its contents can be abridged as the *'Philosophy of Information Systems Research.'* This chapter provides a methodological road map to matters that should be deliberated and incorporated by researchers whenever they choose to embark on IS research. This researcher accedes to Mavetera (2011), who argued that any type of information system research should answer the following questions:

- What type of research is being carried out? This inspects the dichotomy or the irreconcilable difference between theoretical and empirical types of research.
- What is the purpose of the research being it the generation of theory or testing of theory? The research errand should then be constructive, nomothetic or ideographic.
- With respect to the research problem, how should its nature be perceived? The four sociological paradigms, together with the ontological, epistemological and humanist philosophical foundations, should be used as lenses to comprehend the research problem. What research paradigm should an information systems research project follow? This question is responded to by looking at the dichotomy between qualitative and quantitative research paradigms in combination with the three tactics used in IS research which are positivist, interpretive and critical realism.

- What is the elicitation or positioning of the nature of the research problem? This question guides this researcher by assisting in the selection of the appropriate methodological processes which addresses the research problem.

A summary of this chapter is offered in Table 3.4 by stressing the key choices this researcher has made in order to carry out the research.

Research Decision	Selected Option
Philosophical Underpinnings: The selected epistemological and ontological choices	Critical Realism, relativist, non-positivist, and interpretive
Research Methodology	Mixed Methods Research (Qualitative, Quantitative and Design Science Research)
Nature of the Research Problem	Ontologically (structurally separated vast Actor-Networks and neo-humanist); epistemologically (relativistic and subjectivist or transactional, relations are both material and semiotic); humanistic diagnosis (voluntarist, determinist and rational, subjectivist)
Data Collection Techniques	Surveys, Face-to-face exploratory interviews, document analysis, Systems Analysis and Design
Research Setting	South African higher education sector: information technology champions at various universities, business intelligence specialists, Management information specialists, and institutional researchers and data scientists
Units of Analysis	Business Intelligence Systems and tools, Higher education business Intelligence domain, Design of a Business Intelligence Framework and artefacts
Research Scope	A Context-aware Business Intelligence Framework for SA Higher Education
Timelines	Pilot Study in South African higher education: November 2014 – February 2015; Data Collection in South African Higher Education: February 2015 to November 2015; Development of CABIF: November 2015 Data Collection at Univen: November 2015
Data Analysis Framework	Surveys: Exploratory factor analysis using Principal Component Analysis TAM Survey: Logistic Linear regression analysis Textual Data: Thematic and pattern analysis Design Science Research: Artefact design using system analysis and design

Table 3.4: Summary of Research Design and Methodology

Critical realism is considered as the dominant philosophical underpinning of this research, because it allows for the plurality of structures and generative mechanisms that create the

events that occur or do not occur. CR therefore, permitted this researcher to select the mixed methods research design. The epistemological stance of CR regarding the knowledge claim posits it as non-positivist, meaning that values and facts are intertwined and difficult to disentangle. In this researcher's view, the structural conditioning of BI systems in SAHEIs is relatively independent and enduring, existing materially in the real domain of the SA higher education. The instantiation of BI systems in SAHEIs entails that they are not malleable structures, existing only in the empirical domain, but in the real and theoretical domains as well.

Chapter 4 : Data Analysis - Results Presentation and Discussions

4.0 Introduction

The previous chapter detailed the research methods, research design, the philosophical underpinnings, data collection and data analysis approaches this researcher used in the research. This chapter will consider the data analysis of the data collected during the fieldwork, followed by the presentation and discussions of the research results. The main aim of carrying out this research was, to develop and implement a Context-aware Business Intelligence Framework (CABIF) for the South African higher education sector. The first part of this chapter will show how the data collected from the 47 respondents during the pilot phase assisted in refining the business intelligence survey which was administered within the higher education sector.

The second part of this chapter will further show how the PCA, assisted to identify and extract important business intelligent factors, which were used in design science research techniques to develop the context-aware business intelligence framework. The data presented and analysed in the second part of this chapter were obtained from online, face-to-face and telephonic administered surveys, completed by 258 (n=258), professionals from the South African higher education sector. These data were used to address the first two research questions which are:

RQ1 *What are the conceptual foundations of the business intelligence frameworks currently used in the South African Public Higher Education Institutions?*

RQ2 *Are these Business Intelligence technological entities theoretically and practically contextualised?*

In this chapter, this researcher will also show how the data collected from relevant documentation from the higher education sector, complimented the development of CABIF using DSR approaches. This researcher will also demonstrate how the BI factors extracted through PCA were complemented by adding factual, procedural and prescriptive knowledge of business intelligence, in order to develop the context-aware business intelligence framework using the design science research conceptual framework. However, as has been mentioned in the previous chapter, a pilot survey was initially within the SAHEIs, as a means of validating, verifying and testing the accuracy of the survey items. This pilot survey was followed by a subsequent data analysis.

4.1 Phase I - Pilot Data Analysis

As mentioned in the previous chapter, the researcher subjected the data collected from the 47 respondents during the pilot phase to principal components analysis. The anticipation to execute the PCA was to load onto various factors separately for the satisfaction and importance of the BI characteristics drawn from four different BI dimensions (*Business and Technology Alignment; Organizational and Behavioural Strategies; Business Intelligence; Technology Strategies*). PCA was set to extract as many BI factors as was possible. The number of the needed BI factors as determined by the PCA both for *satisfaction* and *importance* based on the correlation matrix of the measured variables. The result of this process allowed the researcher to choose a fixed number of BI characteristics that this researcher further investigated for their reliability and validity. The Cronbach's α reliability tests were done to check the reliability of the survey and these reliability tests assisted in spotting survey items that were reducing the Cronbach's α of each of the BI characteristic.

The researcher specifically looked for both **satisfaction** and **importance** factors that were loading below the 0.7, and these were subjected to further investigation. Items that were loading highly on the **satisfaction** and **important** factors were identified, and to this researcher, these factors indicated that they needed a further review. These items were also reviewed based on the clarity of the text, as the researcher found out that some of the items were double-barrelled. At the pilot phase as indicated earlier, the main purpose was to develop a survey instrument that was having a high degree of reliability and validity. Respondents who participated in the pilot study and the research experts who looked into the survey assisted the researcher in achieving this goal. The feedback and suggestions from these groups of people were incorporated to come up with the revised web survey, which was deployed online. The survey on business intelligence was deployed at the SAHEIs which gave the researcher ethical clearances or approvals.

The pilot data collection was conducted in November 2014 through to February 2015. This researcher sent an e-mail to the participants, with the covering letter attached and a link to the survey. There were three follow-up e-mails, to the same respondents and in total 47 responded to the survey. All the questions in the survey were mandatory prior to submission, and this resulted in no missing values across all the 47 respondents who responded to the pilot survey. The collected pilot data was subjected to the principal components analysis using varimax rotation, and a number of BI factors were extracted under the constraints of

eigenvalues greater than one. A total of 32 BI factors resulted with a cumulative variability of above **70%** and high Cronbach's α . These values are shown in Appendix C1 and C2.

This researcher concurs with Porter & Donthu (2006), who argued that Cronbach's α values, especially those with a value of 0.8 and above are acceptable measures of the reliability of survey instruments. Using the factor loadings on the separate analysis for **satisfaction** and **importance** BI factors, the results suggested that the researcher needed to make minor changes to seven items, and do trial runs on the time spend on responding to the survey. The pilot phase provided the initial validity and reliability of the survey instrument, the data was not subjected to any further analysis. The survey items that were revised are 33 through to 37, in Appendix A1, and they resulted in the final survey on Business Intelligence deployed in the South African higher education institutions.

4.1.1 Selection of Business Intelligence Factors to Load

The business intelligence variables/factors that were subjected to PCA were 34 in total, and in this case the researcher subjected both the satisfaction and their importance based on the respondents' responses to the survey. In total the survey had 37 variables, and the other three variables were textual and also one had to indicate the institution where the respondent was working. Once the extraction of factors had been completed, the researcher examined the table of **Communalities** which reflected on how much of the variance in each of the original variables was being explained by the extracted factors. The table of communalities for satisfactory variables is shown in Appendix C1 and for the importance factors it is shown in Appendix C2. The communality for a given variable can be interpreted as the proportion of variation in that variable explained by the extracted factors in PCA data analysis. One evaluation of how well this factor model is doing can be obtained from the communalities. This researcher chose the measurable BI satisfaction and importance variables, according to Porter & Donthu (2006), who selected the values of the communalities close to one. The reason being that, if values are close to one, this would indicate that the model explains most of the variation for those variables. As observed in Appendix C1 and Appendix C2, the model does better for all of the 34 variables.

4.1.2 Explanation of the Values of Communalities in the Pilot Data Analysis

The meaning of the communality of a variable is explained by taking an example of twelve variables of the data which is an extract of Appendix C1. This means that in the data analysis

for the respondents' satisfaction with BI systems at their institutions, one would obtain an $R^2 = 0.759$, if one had performed a multiple regression of Business and Technology Alignment variable against the five common factors extracted through PCA. This result indicates that about 75.9% of the variation in *Business and Technology Alignment* is explained by the factor model. The results suggest that the factor analysis does the best job of explaining variation in all the 34 variables. As an example, in Table 4.1, a variance of 75.9% in the Business and Technology alignment variable is explained by the five extracted components.

Communalities		
	Initial	Extraction
BTAalign_S	1.000	.759
BTAsystem_S	1.000	.800
BTAquality_S	1.000	.785
BTAerrors_S	1.000	.728
BTAaccess_S	1.000	.744
BTAdecisions_S	1.000	.761
BTAtools_S	1.000	.756
BTArepaccess_S	1.000	.816
BTAwork_S	1.000	.742
OBSpolitics_S	1.000	.841
OBSemc_S	1.000	.839
OBSadopt_S	1.000	.637

Table 4.1: A Sample of Communalities for Business Intelligence Satisfactory Measures

Relating to Porter & Donthu (2006), when the researcher did the data analysis using PCA higher communalities are essential. If the value of a communality for a variable/factor is less than 50%, it is a probable candidate for omission from the analysis because the factor solution contains less than half of the variance in the original variable, and the explanatory power of that variable might be better represented by the individual variable.

Communalities		
	Initial	Extraction
BTAalign_I	1.000	.734
BTAsystem_I	1.000	.804
BTAquality_I	1.000	.812
BTAerrors_I	1.000	.883
BTAaccess_I	1.000	.838
BTAdecisions_I	1.000	.818
BTAtools_I	1.000	.746
BTArepaccess_I	1.000	.809
BTAwork_I	1.000	.704
OBSpolitics_I	1.000	.695
OBSemc_I	1.000	.713
OBSadopt_I	1.000	.753

Table 4.2: A Sample of Communalities for Business Intelligence Importance Measures

The data analysis yielded two tables of Communalities, one for satisfaction and for the importance of BI factors for all variables above 0.50, therefore no variable was excluded based on low communalities. As an example, in Table 4.2, 73.4% of the variance in the Business and Technology alignment variable is explained by the 11 extracted components for the importance of BI systems within higher education. If a decision was taken to exclude a variable for a low communality, a re-run of PCA without that variable before proceeding would have taken place.

Monte Carlo Principal Analysis for Parallel Analysis

A more scientific method of determining which factors to load, was adopted. As shown in Table 4.3, the Monte Carlo Principal Analysis for Parallel Analysis method was used to determine the factors to include in the final survey. For the 34 variables with 50 respondents and replications of responses in the data at least 14 variables are loaded which had eigenvalues of one and above. A total of 21 variables would also have an Eigenvalue of above 0.5, which is 62% of the 34 variables considered for PCA.

Monte Carlo PCA for Parallel Analysis Version. 12/22/2015 10:03:08 AM		
Number of variables: 34, Number of subjects: 50; Number of replications: 100		

Eigenvalue #	Random Eigenvalue	Standard Dev

1	3.0306	.1747
2	2.6799	.1157
3	2.4703	.0894
4	2.2770	.0910
5	2.1092	.0807
6	1.9279	.0666
7	1.8005	.0653
8	1.6701	.0633
9	1.5521	.0600
10	1.4334	.0541
11	1.3296	.0492
12	1.2282	.0488
13	1.1345	.0523
14	1.0483	.0516
15	0.9594	.0473
16	0.8800	.0403
17	0.8078	.0389
18	0.7434	.0404
19	0.6759	.0365
20	0.6095	.0346
21	0.5476	.0392
22	0.4982	.0339
23	0.4410	.0365
24	0.3878	.0340
25	0.3396	.0284
26	0.2987	.0253
27	0.2563	.0257
28	0.2166	.0229
29	0.1831	.0188
30	0.1485	.0190
31	0.1180	.0174
32	0.0909	.0156
33	0.0660	.0144
34	0.0401	.0126

12/12/2015 10:03:13 AM; Monte Carlo PCA for Parallel Analysis ©2000 by Marley W. Watkins. All rights reserved.		

Table 4.3: Monte Carlo Principal Analysis for Parallel Analysis

The final decision taken was to use all the variables, based on the values of the communalities tables which were all above 50%, and substantial amount variables with eigenvalues above one, and close to one if rounded off. This researcher then deployed the refined BI survey in the SA public universities and collected data from 258 respondents.

4.2 Phase II – Quantitative Data Analysis of the Business Intelligence Survey

The factor analysis is very different from other inferential statistical techniques, where the researcher needs to compare groups, or looks for relationships, correlations or regressions or predictions among variables. As has been mentioned earlier, factor analysis is a data reduction technique, as it takes a potentially large set of variables and looks for a way that the data can be reduced or summarised using a smaller set of variables or components. It does this by looking for clumps or groups of variables that have very strong inter-correlations within a set of variables. This is very difficult for one to do by eye, as one can look for correlations or correlations matrix from a small number of variables, but as the number of variables increase one would need a statistical package to assist. Factor analysis techniques have a lot of different uses. In this study, this researcher wanted to evaluate what South African higher education BI practitioners, thought were the most important BI factors.

This researcher did not use the standard factor analysis technique, but has used the PCA, as has been shown in the data analysis framework. PCA was a better choice because, this researcher wanted to do an empirical research on the practical application of BI factors within the SAHEIs. The outcome that was obtained from the PCA, were a set of components from the measurement tool, which was, the SAHEI BI Survey. This researcher first assessed the data for its suitability for PCA. The researcher considered the sample size and the relationship among the variables in the measurement tool. Research has shown that, the bigger the sample, the more reliable the correlation matrix among the variables, (Wuenssch, 2012). Ratio of participants per items is also considered, as research has shown that each item should have ten or more respondents. According to Appendix D1, the descriptive statistics for the BI satisfactory factors, shows that each item had 258 respondents and the same applies to the BI importance factors. This has been attributed by the fact that in the online survey, the researcher set each item in the survey to be mandatory.

With principal components analysis, or factor analysis in general the researcher was able to demonstrate the construct validity of the SAHEI BI Survey. This researcher could safely say

that, all the items in the survey, altogether represented the underlying BI dimensions and constructs which the researcher was measuring quite well. This is because with any type of factor analysis, research has shown that it identifies the elements that underlie a dataset grounded on the correlations between the variables (Wuensch, 2012). The factors that explicate the maximum share of variance for the variables share are anticipated to epitomize the principal constructs.

4.2.1 The Main Quantitative Data Analysis Process: Principal Components Analysis

In this research, this researcher used the information from the PCA along with a diagramming technique in order to be able to summarize the results in a diagram form. The research has left out all the observed variables where the loadings of the factor were between -0.3 and +0.3 exclusive. The data analysis followed a clearly defined set of steps, and these were as follows:

- i. The preparation of the set of the observed satisfactory and importance BI measures
- ii. Inspection of the correlation matrix of the observed variables
- iii. Assessing the statistics of the data set for the suitability of the basis of PCA. These statistics included the determinant measures, KMO and the Bartlett's test of sphericity.
- iv. Extraction of the BI factors using PCA
- v. Varimax rotation of the BI factors to allow for interpretation using design science research
- vi. Attribution of names to the extracted BI factors using the DSR principles
- vii. The interpretation of the scores of the BI factors as a means of constructing the context-aware business intelligence solution for the South African higher education sector.

The researcher started with 34 individual items on a satisfactory and importance Likert dual-scale, as defined in the SA higher education BI survey deployed. Using the PCA techniques, the researcher could refine and reduce these data sets or variables, into a smaller number or subscales that measured the BI constructs together. The large number of related variables were subjected to factor analysis, to give a more manageable and efficient number of variables to measure the BI constructs. These smaller number of variables ensured that there was no redundancy in the measurements. In the main quantitative data analysis, the researcher wanted to confirm the theories, and the structure underlying the set of variables,

hence confirmatory analysis. The latent and observed variables that were used in PCA are shown in Figure 4.1. The full set of latent variables, observed variables, variable coding and definitions are shown in Appendix D2.

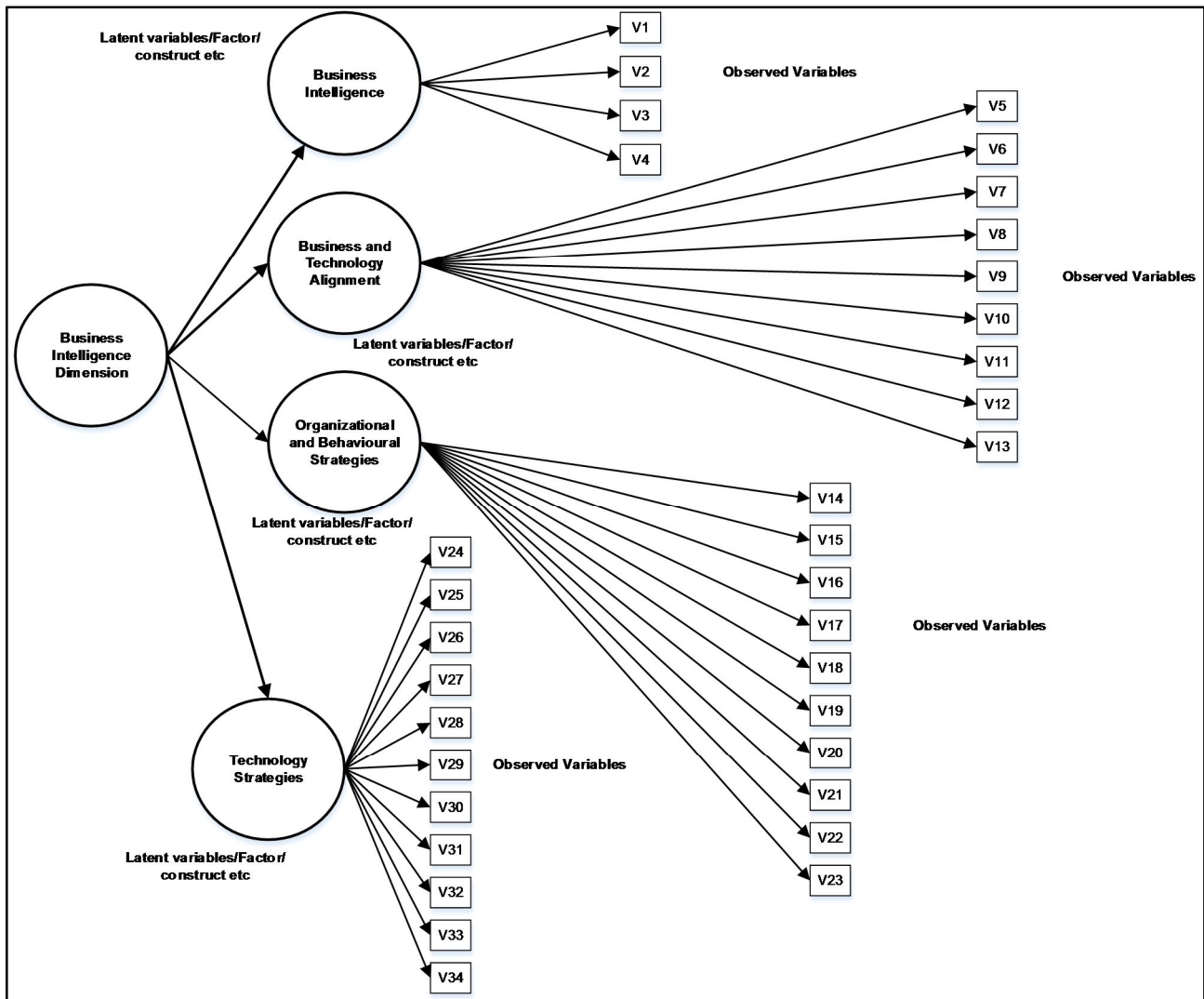


Figure 4.1: Business Intelligence The latent and observed variables

4.2.2 The Analysis of the Business Intelligence Latent Variables

The four BI dimensions in the research which constituted the latent variables, had each a set of observed variables as shown in Figure 4.1. These latent variables were, Business and Technology Alignment (BTA) with nine observed variables; Organizational and Behavioural Strategies (OBS) with ten observed variables; Technology Strategies (TS) with eleven observed variables and Business Intelligence (BI) with four observed. Each BI dimension was analysed separately to see the respondents' satisfaction and importance for each

dimension. This researcher was seeking to see if analysing each value, would make any meaningful contribution to this research.

4.2.2.1 Analysis of the Business and Technology Alignment Dimension

The nine variables that constituted the Business and Technology Alignment were analysed as shown in the Table 4.4. The communality statistics table shows the measure of how well each of the selected factors (principal components) "explain" the variance of each of the variables. The Quality of Technical Support, explained 76% of the principal components in the BTA dimension. The variable (*BTAdecisions_S*), which tells if "Top decision areas" in the institution are addressed and prioritised within the institutional business intelligence system only accounts for 63% of the variance among the BTA principal components.

Business and Technology Alignment Satisfactory Dimension: Communalities				
Component	Variable Name	Variable Description	Initial	Extraction
1	<i>BTAalign_S</i>	Technology and Business alignment	1.00	.71
2	<i>BTAsystem_S</i>	System Response time	1.00	.67
3	<i>BTAquality_S</i>	Quality of Technical support	1.00	.76
4	<i>BTAyserrors_S</i>	Frequency of System Errors	1.00	.70
5	<i>BTAaccess_S</i>	Access to data and reports via the internet	1.00	.69
6	<i>BTAdecisions_S</i>	Top decision areas are addressed and prioritised in the Business intelligence system	1.00	.63
7	<i>BTAtools_S</i>	Business intelligence tools to support decision making processes	1.00	.73
8	<i>BTArepaccess_S</i>	Access of data and reports from a single area	1.00	.74
9	<i>BTAwork_S</i>	IT and University core business teams working together	1.00	.73

Table 4.4: Communalities of the Business and Technology Alignment Satisfactory Dimension

The communalities refer to the proportion of each variable's variance that can be explained by the principal components (e.g., the underlying latent continua). These are also noted as h^2 and can be defined as the sum of squared factor loadings. The 'Initial' value of the communality in a principal components analysis is 1. The values in the 'Extraction' column indicate the proportion of each variable's variance that can be explained by the principal components. Variables with high values are well represented in the common factor space, while variables with low values are not well represented. In this study, no low values were obtained. The values in the 'Extraction' column are the reproduced variances from the number of components that were saved. These values are also found on the diagonal of the reproduced correlation matrix.

4.2.2.1.1 Business and Technology Alignment Correlation Matrix

This researcher suspected that an unidentified number of hidden variables may explain the relationship between the nine observed BTA variables. In multivariate data analysis, the relationship between observed variables is typically described using the standardized variance/covariance matrix (i.e., the correlation matrix shown in Table 4.5). As expected the observed value of the variances in the correlation matrix is 1 for all the variables in the diagonal. For this BTA business intelligence dimension dataset, the visual examination of the correlation matrix offered vital information. The Correlation matrix among the nine BTA dimension variables shows that the cluster of correlation values is greater than 0.20 and each one is indicated as a combined cluster in bold.

	<i>BTAalign_S</i>	<i>BTAsystem_S</i>	<i>BTAquality_S</i>	<i>BTAsyerrors_S</i>	<i>BTAaccess_S</i>	<i>BTAdecisions_S</i>	<i>BTAtools_S</i>	<i>BTArepass_S</i>	<i>BTAwork_S</i>
<i>BTAalign_S</i>	1.00	.76	.77	.62	.64	.61	.70	.63	.64
<i>BTAsystem_S</i>	.76	1.00	.74	.67	.65	.48	.60	.64	.65
<i>BTAquality_S</i>	.77	.74	1.00	.72	.70	.67	.65	.64	.70
<i>BTAsyerrors_S</i>	.62	.67	.72	1.00	.69	.71	.62	.67	.63
<i>BTAaccess_S</i>	.64	.65	.70	.69	1.00	.63	.67	.69	.64
<i>BTAdecisions_S</i>	.61	.48	.67	.71	.63	1.00	.67	.68	.59
<i>BTAtools_S</i>	.70	.60	.65	.62	.67	.67	1.00	.75	.79
<i>BTArepass_S</i>	.63	.64	.64	.67	.69	.68	.75	1.00	.82
<i>BTAwork_S</i>	.64	.65	.70	.63	.64	.59	.79	.82	1.00

Table 4.5: Business and Technology Alignment Correlation Matrix

The result indicated that the observed variables in each cluster share a large amount of variance, that is, the amount of common variance, which have also been confirmed by the communality table, as being high.

4.2.2.1.2 Business and Technology Alignment Dimension Variance Explained

Although the “*Technology and Business alignment*” variable explains 70.72% of the variance, it only shows how the respondents view it as an important factor for a business intelligence framework or strategy, but the other factors are valuable as well. The IT and University Core Business Teams working together variable (*BTAwork_S*), only accounts for 1.32% of the variance.

Business and Technology Alignment Satisfaction Dimension: Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.36	70.72	70.72	6.36	70.72	70.72	6.36	70.72	70.72
2	.62	6.88	77.60						
3	.55	6.08	83.68						
4	.39	4.29	87.97						
5	.33	3.63	91.60						
6	.25	2.77	94.38						
7	.23	2.57	96.95						
8	.16	1.73	98.68						
9	.12	1.32	100.00						

Table 4.6: Business and Technology Alignment Dimension Variance

The Table 4.6 illustrates that if the aim was to explain 100% of the variance in the correlation matrix, then the researcher would need to preserve as many factors as the observed variables (which would not make any sense at all). However, the notion in PCA is to select an optimum quantum of factors. The ideal number of factors/components can be defined as the minimum number of factors/components that accounts for the maximum possible variance.

The visual inspection of the correlation matrix in Table 4.5, intuited that retaining all the components should be enough for the BTA dimension dataset. However, retaining only one component based on the accumulated percentage of explained variance of 70.72%, would suggest a poor fit of the component solution. To achieve an acceptable fit, it seems that the researcher should retain at least five components, which are greater than 50% of the variables. In this case, it seemed very clear that the percentage of explained variance does not put forward an optimal number of components to be retained. The percentage of explained variance of each factor can be effortlessly calculated as the analogous eigenvalue divided by the total variance, e.g., the percentage of variance explained by the first BTA component is $6.36 / 9 = .7072$ (or in terms of percentage 70.72%).

4.2.2.1.3 Conclusion to Business and Technology Alignment Analysis

In the BTA dimension dataset, the entire quantity of variance is 9. This whole quantum of variance can be apportioned into dissimilar parts where each part characterises the variance of each factor. The eigenvalues printed in Table 4.6 represent the amount of variance associated with each component. If the eigenvalues are added, the resulting total should be the total variance in the correlation matrix (i.e., the addition $6.36 + 0.62 + \dots + 0.12$ should be equal to 9). The reason why the percentage of explained variance does not suitably

pronounce the goodness of fit for the BTA dimension, is because PCA is not an accurate estimate of exploratory factor analysis for this BTA dimension dataset. If the researcher continued the analysis with the initial idea of retaining one component based on the eigenvalue greater or equal to 1, as Wuensch (2012) suggested, and rotated the loading matrix with varimax rotation, the simplicity of the component solution obtained seems to reinforce the initial intuition, i.e., of retaining all the nine components. The loading matrix of component solution after Varimax rotation showed that the salient loading was all greater than 0.2, therefore the researcher had to load all the nine satisfactory BTA dimensions, in the overall main quantitative data analysis.

4.2.2.2 Analysis of the Organizational and Behavioural Strategies Dimension

The business intelligence organizational and behavioural strategies (OBS) dimension, comprised of ten observed measures that intended to leverage the business intelligence knowledge of the key institutional stakeholders. The researcher extracted the communalities for the OBS latent variable which estimated the part of the variability in each variable that is being shared with others, and which is not due to measurement inaccuracy or latent variable's effect on the observed variable. The Communalities (Initial) table, the variance shared by each of the observed variables were relatively high as shown in Table 4.7.

Communalities					
	<i>Initial</i>	<i>Extraction</i>		<i>Initial</i>	<i>Extraction</i>
<i>OBSpolitics_S</i>	1.00	.78	<i>OBSpolitics_I</i>	1.00	.73
<i>OBSemc_S</i>	1.00	.76	<i>OBSemc_I</i>	1.00	.76
<i>OBSadopt_S</i>	1.00	.65	<i>OBSadopt_I</i>	1.00	.54
<i>OBSskills_S</i>	1.00	.72	<i>OBSskills_I</i>	1.00	.66
<i>OBSdesign_S</i>	1.00	.71	<i>OBSdesign_I</i>	1.00	.66
<i>OBSgovernance_S</i>	1.00	.82	<i>OBSgovernance_I</i>	1.00	.64
<i>OBSdatagov_S</i>	1.00	.73	<i>OBSdatagov_I</i>	1.00	.49
<i>OBSstratalign_S</i>	1.00	.80	<i>OBSstratalign_I</i>	1.00	.71
<i>OBSstandards_S</i>	1.00	.82	<i>OBSstandards_I</i>	1.00	.48
<i>OBSictprovision_S</i>	1.00	.80	<i>OBSictprovision_I</i>	1.00	.41

Table 4.7: Communalities for the Organizational and Behavioural Strategies Dimension

What was initially done in the main data analysis was to repackage the variance from the different satisfactory and importance measures into correlated variables into a number of uncorrelated components. The reason was to identify if the observed variables in reality shared considerable variance, several of the components would have large eigenvalues and many should have small eigenvalues. The components extraction rule of thumb was to retain

only components with eigenvalues of one or more. That is, the researcher would drop any component that accounted for less variance than does a single variable. The researcher extracted the principal components for each BI dimension. The correlation matrix was given good look, because the researcher had planned to use PCA to capture the essence of the correlations in this matrix.

4.2.2.2.1 Organizational and behavioural strategies Correlation Matrix

In the correlation matrix shown in Table 4.8, there are many medium to large correlations in this matrix, and that every variable, except OBSskills_S, has some large correlations, and OBSskills_S is moderately correlated with everything else (positively). The intention to inspect the correlation matrix was to see if there were any variables that were not correlated with the other variables. The expected pattern of the unrotated factor loadings, with high positive loadings were on the first factor. These rotated factors were just as good as the initial factors in explaining and reproducing the observed correlation matrix. The Squared Multiple Correlation coefficient (SMC or R^2) of each observed variable for the organizational and behavioural strategies with all other variables was then inspected.

	OBSpolitics_S	OBSemc_S	OBSadopt_S	OBSskills_S	OBSdesign_S	OBSgovernance_S	OBSdatagov_S	OBSstratalign_S	OBSstandards_S	OBSictprovision_S
OBSpolitics_S	1.00	.85	.55	.10	.56	.57	.48	.67	.61	.65
OBSemc_S	.85	1.00	.61	.15	.56	.60	.45	.59	.57	.67
OBSadopt_S	.55	.61	1.00	.16	.64	.72	.62	.61	.68	.69
OBSskills_S	.10	.15	.16	1.00	.20	.36	.31	.34	.35	.25
OBSdesign_S	.56	.56	.64	.20	1.00	.78	.66	.78	.70	.73
OBSgovernance_S	.57	.60	.72	.36	.78	1.00	.74	.77	.76	.79
OBSdatagov_S	.48	.45	.62	.31	.66	.74	1.00	.74	.79	.72
OBSstratalign_S	.67	.59	.61	.34	.78	.77	.74	1.00	.83	.71
OBSstandards_S	.61	.57	.68	.35	.70	.76	.79	.83	1.00	.79
OBSictprovision_S	.65	.67	.69	.25	.73	.79	.72	.71	.79	1.00

Table 4.8: Organizational and behavioural strategies Correlation Matrix

The observed variables with small R^2 were unique variables, and these implied that they were not well correlated with a linear combination of the other variables. The researcher then decided to use all the ten OBS observed variables in the final quantitative data analysis.

4.2.2.2.2 Conclusion to Business and Technology Alignment Analysis

The principal components extraction produced ten components which in aggregate accounted for all of the variance in the ten variables. That is, the sum of the 10 eigenvalues

was equal to ten, which is the number of variables. A principal component with a very small eigenvalue does not do a good job of clearing up the variance in the data. In the risky case, if a principal component had an eigenvalue of zero, then it would mean that it described none of the variance in the set of data. For the Organizational and Behavioural Strategies Dimension data set, it was important to consider all the observable variables in the main quantitative data analysis.

4.2.2.3 Analysis of the Technology Strategies Dimension

The researcher's intention of using PCA was to condense the information into a correlation matrix. The total amount of variance in the correlation matrix was calculated by adding the values on the diagonal of the correlation matrix. Each element of the technology strategies variables lying in the diagonal of the correlation matrix has a value of 1, as indicated earlier and the total amount of variance also corresponded to the eleven observed variables. The intention to inspect the correlation matrix was to see if there were any variables that were not correlated with the other variables. The researcher decided to take all the Technology Strategies Dimension data set, in the main quantitative data analysis.

4.2.2.4 Analysis of the Business Intelligence Dimension

A decision was made to take all the BI Dimension data set, in the main quantitative data analysis. The reason was that, the researcher could not subject the data to PCA as there were only four observed variables in the BI dimension. The researcher needed at least a minimum of five observed variables.

4.2.3 Business Intelligence Characteristics in South African Higher Education

The pilot data analysis assisted the researcher in inspecting the variables, and made a decision of observing the 34 variables twice. The first observation was for the satisfactory BI components and the second was their importance based on the opinions of the respondents. Any statistical data analysis starts with conventional data preparation techniques, and any factor analysis is not an exception. The researcher started the analysis by looking at the elementary descriptive statistics for the variables, see Appendix D1. The purpose of carrying out descriptive statistics was to look for abnormal values in the data, or note any missing values and exclude them from the analysis.

4.2.3.1 Overview of the Data Analysis Process

Considering the SA higher education BI stakeholders' satisfaction with BI systems and how they value these systems (measured by the importance variables) within their institutions, all the 34 BI variables were needed to measure satisfaction or importance in the same direction, where a score of 1 represents least satisfaction and a score of 6 represents high satisfaction. The same applied to the value of each of the variables which was given by the respondents. A score of 1 represent least important and a score of 6 represent that it was an extremely important BI factor. All computed variables with a correlation equal to 1 were excluded from the analysis, with respect to the variables from which they were computed as these slickly speak of linear transformations. It is also important to note that all the variables have to measure the construct in the same direction, as the researcher chose varimax rotation which is an orthogonal type of rotation. All that matters were that all the 34 survey items, considered for PCA scored in the same direction.

The descriptive statistics showed that there were 258 respondents from the SAHEIs, and there were no out of range values or any missing data. This was afforded by the fact that all the survey items were mandatory and multiple choice, except for those which needed text based responses. Considering the data set for the BI satisfactory variables the computed inter-correlation matrix for the 34 variables, did not contain any "1", except the expected values in the diagonal, see Appendix D3.

4.2.3.1.1 The Business Intelligence Satisfactory Variables Inter-Correlation Matrix

The point of departure any factor analysis technique is the variable inter-correlation matrix. This is because all factor analysis techniques have a tendency of clumping subgroups of variables together based on their correlations. The visual inspection of the correlation matrix, will definitely give a gut feeling of what factors to consider. This is done by spotting the cluster of high correlations between the groups of variables. Having a look into the correlation matrix in Appendix D8, and take an extract as in Table 4.9, one can notice that the variable *TSmethods_S [SAT_26]*, i.e., the variable that measured the respondents' satisfaction with methodological processes for BI implementations at their institution has inter-correlations less than 0.2 with all the other variables. The same can be said to the *OBSskills_S [SAT_13]* the variable that measured the respondents' satisfaction with the business intelligence competency and skills within their institution. The researcher subscribes to Wuensch (2012) who stated that, if there are few correlations above 0.3, it is

a waste of time carrying on with the analysis, and if one looks into the inter-correlation matrix in Appendix D8, absolutely there is no problem in carrying out PCA.

	SAT_1	SAT_2	SAT_3	SAT_4	SAT_5	SAT_6	SAT_7	SAT_8	SAT_9	SAT_10	SAT_11	SAT_12	SAT_13	SAT_14	SAT_15	SAT_16	SAT_17	SAT_18	SAT_19
SAT_13	0.05	0.07	0.11	0.27	0.25	0.16	0.11	0.14	0.14	0.10	0.15	0.16	1.00	0.20	0.36	0.31	0.34	0.35	0.25
SAT_14	0.38	0.55	0.51	0.57	0.51	0.47	0.51	0.58	0.56	0.56	0.56	0.64	0.20	1.00	0.78	0.66	0.78	0.70	0.73
SAT_21	0.37	0.37	0.39	0.57	0.35	0.52	0.49	0.54	0.45	0.61	0.59	0.68	0.19	0.74	0.76	0.69	0.74	0.74	0.88
SAT_25	0.28	0.38	0.34	0.43	0.31	0.45	0.43	0.51	0.44	0.56	0.53	0.58	0.24	0.56	0.62	0.68	0.67	0.73	0.75
SAT_26	0.14	0.02	-0.03	0.12	0.09	0.13	0.04	0.13	0.06	0.11	0.10	0.05	0.32	0.08	0.17	0.07	0.19	0.19	0.10
SAT_27	0.41	0.45	0.40	0.44	0.37	0.40	0.49	0.44	0.51	0.51	0.54	0.54	0.24	0.60	0.58	0.54	0.64	0.66	0.63
SAT_28	0.47	0.51	0.46	0.46	0.36	0.37	0.45	0.49	0.52	0.53	0.53	0.53	0.19	0.56	0.55	0.52	0.56	0.57	0.59
SAT_29	0.49	0.56	0.51	0.56	0.47	0.44	0.53	0.50	0.57	0.47	0.54	0.61	0.26	0.69	0.62	0.57	0.63	0.67	0.61
SAT_30	0.45	0.49	0.46	0.48	0.44	0.41	0.50	0.52	0.48	0.52	0.54	0.61	0.19	0.64	0.63	0.54	0.55	0.56	0.60
SAT_31	0.30	0.29	0.38	0.44	0.34	0.48	0.45	0.48	0.42	0.56	0.56	0.59	0.20	0.63	0.64	0.60	0.63	0.62	0.66

Table 4.9: Business Intelligence Satisfactory Variables Inter-Correlation Matrix

The results above would make the two variables probable candidates for exclusion in the analysis. While the researcher did some visual inspection of the inter-correlation values less than 0.2, with the assistance of Excel Conditional Formatting tool, a probability density function is more appropriate. The probability density function that normally produces the ρ statistic, would greatly assist in making informed statistical data analysis decisions.

4.2.3.1.2 The Reliability and Validity of Business Intelligence Satisfactory Variables

The researcher used the Bartlett test of sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy to make informed decisions on the adequacy of the sample, and these values are shown in Table 4.10. The Bartlett Test of Sphericity compares the correlation matrix with an identity matrix, that is, a matrix with zero correlations, except along the diagonal which will have correlations with values of 1. The ρ values generated by the Bartlett Test of Sphericity should be very small, indicating that it is highly unlikely to have obtained the observed inter-correlation matrix from a population with zero correlation. The Bartlett Test of Sphericity is a statistic that can be used to test the null hypothesis, which the respondents originated from a random population in which the correlation matrix was an

identity matrix. The identity matrix has values of zero except in the main diagonal which have a value of 1s.

The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy does not produce a p value, but research has shown that value over 0.8 and those below 0.5 are considered to be miserable. It is recommended that the values that have a p value below 0.7 be removed from the analysis. The Anti-image correlation matrix shown in Appendix D9 shows the MSA for each of the variable. Only the *TSmethods_S [SAT_26]*, has a value of **0.466^a** which is less than 0.5 and it indicates that it is miserable.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.909
Bartlett's Test of Sphericity	Approx. Chi-Square	11002.398
	df.	561
	Sig.	0.000

Table 4.10: Measure of Sampling Adequacy and Bartlett's Test for BI Satisfactory Measures

As can be seen from Table 4.10, the researcher obtained good values for all the variables for the Measure of Sampling Adequacy, as it is 0.909. The Bartlett Test of Sphericity has an associated p value (sig. in the Table 4.10 of 0.000) of less than 0.001, and by default SPSS reports values less than 0.001 as 0.000. From the above results, the researcher knew that it was possible to continue and perform PCA. Variables that were simply derivations of another were to be excluded in the analysis. Variables that causes multicollinearity, that is, variables that are very highly correlated should also be excluded from the analysis, as valid factor loadings cannot be produced. In addition, as can be seen in the data analysis, PCA would not help the researcher to take the proper decisions either, if the validity of the data for PCA is considered. In this situation, the researcher took the wisest decision to compute the most appropriate technique available in multivariate data analysis, when the information in the correlation matrix in terms of the underlying latent variables was studied, as form of exploratory factor analysis.

4.2.3.1.3 Extraction of the Satisfactory Business Intelligence Factors

The first thing that the researcher considered was the number of observed variables wanted, and SPSS was let to decide by simply selecting all variables with eigenvalues greater or equal to 1. Using the PCA, SPSS extracted 5 factors as shown in the Components Matrix, see Appendix D11. The factor loadings relate to the correlation between the specific observed variable and a specific factor. The higher the correlation values means a closer

relationship among the variables. Since two components are orthogonal, these correlation values are equivalent to the standardised regression coefficients, that is, the β weights as they are known. In this research, there are as many components extracted during a principal components analysis as there are variables that are put into it. The researcher used 34 observable BI variables (survey items 2 through item 36).

The uniqueness for each observed variable is the portion of the variable that cannot be predicted from the other variables, that is, the latent variables. The uniqueness of the variables is found by subtracting the value of the communality from 1. The communality can be interpreted as the percentage of the variability that is predicted by the model. The uniqueness of the variable is therefore the percentage of the variable that is not predicted by the model. The researcher wanted the uniqueness values of the observed variables, to be as low as possible. The component matrix shown in Appendix D11, is also known as the factor pattern matrix or the loading matrix. The entries in the matrix are the correlations between the components and the variables. The researcher inspected the loading matrix for the BI Satisfactory data sets.

4.2.3.1.4 Business Intelligence Satisfactory Factor Loadings

As shown in Appendix D11, the researcher noticed from the output, that two items (***OBSskills_S*** and ***TSmethods_S***) do not load on the first component (always the strongest component without rotation) but created their own retained component, which is the fourth component. A component should have, a minimum of 3 items/observed variables, and therefore the researcher deleted these variables and the fourth component. As can be seen, almost all the variables load well on the first component, all positively with ***TSmethods_S*** having the lowest loading. The second component has few positive correlations and a number of negative loadings. The third component has a majority of negative loadings, and the fourth component is interesting in that it two high positive loadings, and the majority being negative loadings. The fifth component seems to reflect on System (***BTAsystem_S***) and business intelligence skills (***OBSskills_S***). A component plot in rotated space was developed for the variables as shown in Figure 4.2. For each of the variable, the factor loadings were plotted in a three-dimensional vector space, with the vertical loadings on component 1, and in the other axis its loadings on component 2 and finally loadings on component 3.

4.2.3.1.5 Business intelligence Satisfactory Components Plot in Rotated Space

Each component represents an orthogonal (perpendicular) dimension. Five components were retained, and pairwise plots for these components as in Figure 4.2, were developed.

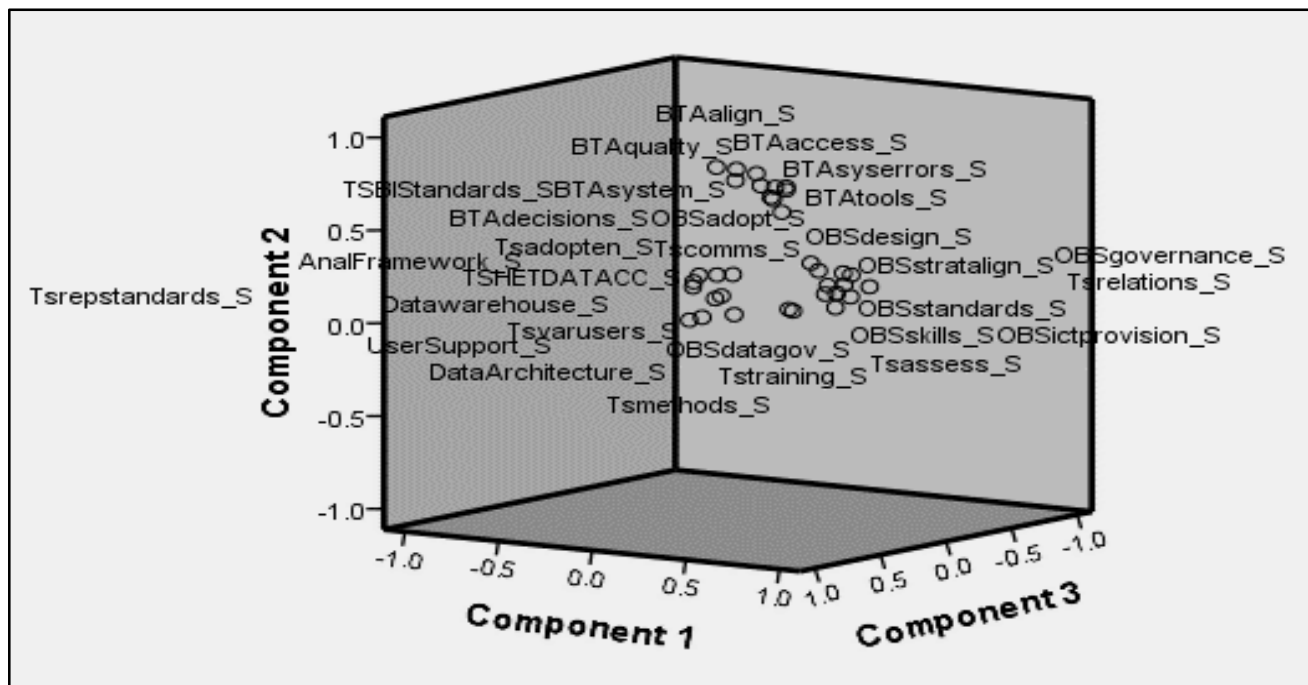


Figure 4.2: Business intelligence Satisfactory Components Plot in Rotated Space

The component matrix has been rotated preserving the perpendicularity, so that one axis passes through or near one cluster, the other through or near the other cluster. The number of degrees by which the axes is rotated, is the angle ψ (**psi**), and for this data, rotating the axes **-41.63** degrees produced the desired effect. The loadings after the rotations are found in Appendix D11 labelled “Rotated Component Matrix^a”. We can see where the observed variables load heavily on which component. The Rotated Factor Matrix table is crucial for comprehending the outcomes of the inquiry. The components are rotated so that they are easier to deduce their meaning. Rotation makes it possible, that, different items are explained or predicted by different underlying factors, and each factor explains more than one item. As has been mentioned by Beaumont (2012), this is a condition called a simple structure. One thing to look for in the rotated matrix of factor loadings is the extent to which the simple structure is achieved. The researcher had showed how the simple structure is maintained by the use of a scree plot. A scree plot displays the eigenvalues associated with a component or factor in descending order versus the number of the component or factor. The scree plots were used to visually assess which components or factors explain most of the variability in the data.

4.2.3.1.6 Scree Plots for Business Intelligence Satisfactory Factors

The scree plot in Figure 4.3 shows that 5 of those BI factor loadings explain most of the variability because the line starts to straighten after factor 5.

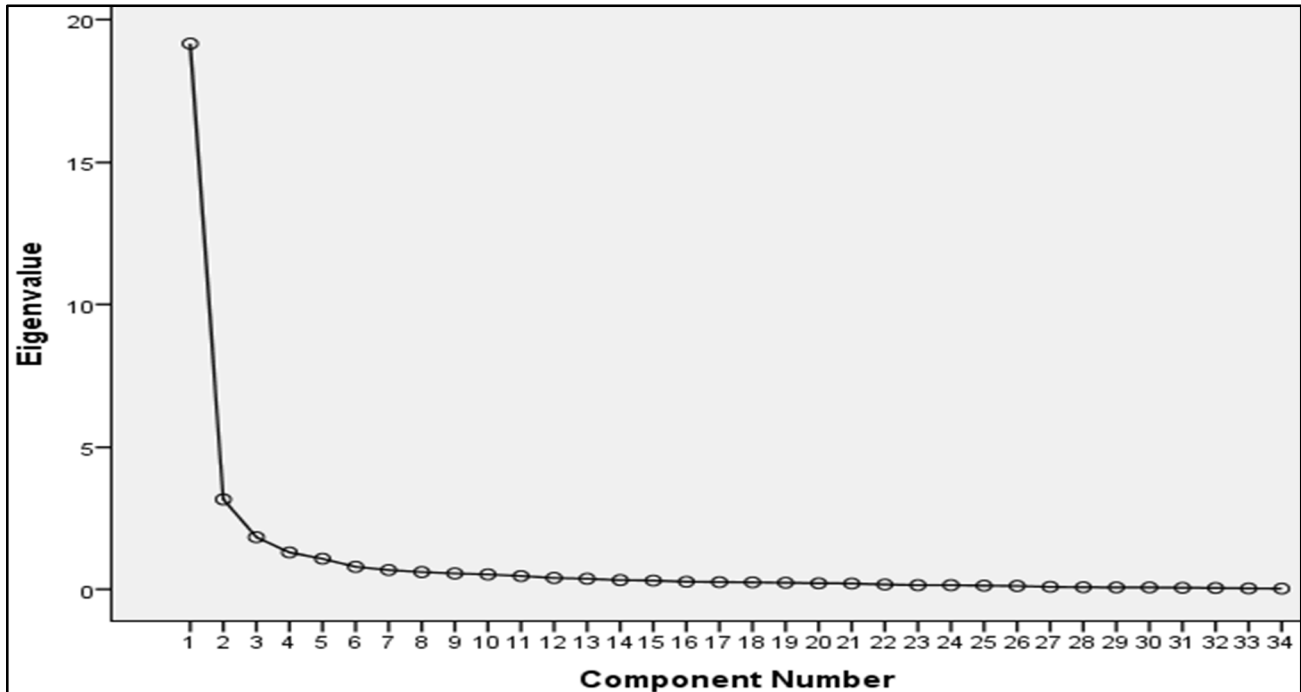


Figure 4.3: Scree Plots for Business Intelligence Satisfactory Factors

As mentioned PCA earlier was conducted on 34 different characteristics of business intelligence systems. The remaining factors explained a very small proportion of the variability and are likely unimportant. The ideal pattern in a scree plot is a steep curve, followed by a bend and then a flat or a horizontal line. Those components or factors in the steep curve before the first point that starts the flat line trend, would have been retained. The researcher had a difficulty interpreting a scree plot, but has used the knowledge of the data and the results from the other approaches of selecting components or factors to help in deciding the number of important components or factors. The MSA, which has shown the number of factors and Appendix D7, which explains the Total Variance, were key in assisting the researcher in making decisions on which values to retain.

4.2.3.1.7 Interpretation of the Total Variance of BI Satisfactory Measures

The values in Appendix D10 in the column labelled Initial Eigenvalues are the variances of the principal components. The researcher conducted PCA on the correlation matrix, to ensure that the variables were standardized, which means that each variable has a variance of 1, and the total variance is equal to the number of variables used in the analysis, in this

case, 34. The column labelled **'Total'**, contains the eigenvalues. The foremost component, will at all times account for the most variance (and hence have the highest eigenvalue), and the next component will account for as much of the left-over variance as it can, and so on. Hence, each successive component will account for less and less variance. The column labelled **'% of Variance'** encompasses the percent of variance accounted for by each principal component, and in this study the first principal component accounts for 56.342% of the variance.

The **'Cumulative %'** column holds the cumulative percentage of variance accounted for by the current and all preceding principal components. For example, the fourth row shows a value of 74.741. This signifies that the first four components collectively account for 74.741% of the total variance. The fact that the researcher is using principal components analysis, all variances were considered to be true and these were common variance. In other words, the researcher assumed that the variables were measured without error, so there is no error variance. The three columns under the label **'Extraction Sums of Squared Loadings'** exactly reproduce the values given on the same row on the left side of the table. The number of rows reproduced on the right side of the table is determined by the number of components whose eigenvalues are 1 or greater.

The section labelled **"Rotation Sums of Squared Loadings"** shows only those factors that have met the cut-off criterion using the PCA extraction method. In this research, there were five factors with eigenvalues greater than 1. The **'% of variance'** column tells how much of the total variability, in all the variables together, can be accounted for by each of these summary scales or factors. In this research for BI satisfactory measures Factor 1 accounts for 26.663% of the variability in all the 34 Satisfactory measures, Factor 2 accounts for 23.100%, Factor 3 accounts for 19.757%, Factor 4 accounts for 4.483% and Factor 5 accounts for 3.833% of the variability in all the 34 satisfactory measures.

4.2.3.4 Results of the Business Intelligence Satisfactory Characteristics

The main data set has been subjected to some form of exploratory factor analysis using the PCA with varimax rotation done separately for satisfaction and importance measures. Using the factor loadings on both analysis, the survey items were closely looked for low loadings (**<0.3**), or medium loading (**~0.3 to 0.6**) on more than one factor. Table 4.11, shows the Cronbach α , used in the principal factor to investigate the reliability and validity of the survey items, and for satisfactory measures, a Cronbach α of 0.975 was obtained. Thus, the data

set for satisfactory measures was highly reliable and valid. Each resultant factor was also subjected to reliability analysis using Cronbach α , and each of the five extracted components had a Cronbach α of above 0.95. The total reliability measure for all the satisfactory measures in the event that each of them was deleted or eliminated from the factor, was also given and is indicated in Appendix D11.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.975	.975	34

Table 4.11: Reliability analysis of BI Satisfactory Factors

Results of the reliability analysis using Cronbach α suggested that no item of the satisfactory measures was worth eliminating. As a result of these analysis, the researcher decided to include all the satisfactory measures into the business intelligence framework, which was going to be developed. In the study, the researcher differentiated between the satisfaction and importance measures of business intelligence systems in the South African higher education institutions. However, it was important to make separate conclusions for each of the data sets included in the research. The following sections shows the conclusions that were drawn from the PCA of the observed satisfactory BI data sets.

4.2.4 Conclusions on Business Intelligence Satisfactory Measures Analysis

The researcher extracted five BI satisfaction factors with a total cumulative variance of **77.885%** with high Cronbach α for all the five factors (**0.980, 0.970, 0.970, 0.970, and 0.970** respectively). Only two observed BI satisfactory variables loaded on the fourth factor, and therefore it was deleted in the final analysis. The results of the PCA to BI satisfaction measures showed that the business and technology alignment dimension form a powerful BI factor. The second BI dimension that is consistent with literature is the Technology Strategies dimension. The low factor loadings in the other BI dimensions might be attributed to the BI skill set that the respondents have. This might be the main reason why the business intelligence skills had a very low correlation value as has been mentioned previously.

It is important to note that PCA, was performed to extract the BI satisfactory factors that could bear the potential to be included in the context-aware BI framework developed. The other survey items were used to understand what BI models, designs, technologies and tools are currently being used in the SAHEIs. The final results for the BI satisfaction measures are provided in Appendix D8. In the next section the results of the PCA analysis to the observed BI importance measures are detailed. These observed BI importance

measures were important to the research, as these mirrored how the respondents value the BI characteristics which were embedded within the survey items.

4.3 Analysis of the Business Intelligence Importance Measures

This researcher performed PCA on the remaining data for the 34 BI importance measures just as was done with the BI satisfactory measures. The correlation matrix for the business intelligence measures is shown on Appendix D12. The correlation matrix is showing how each of the 34 observed importance variables is associated with each of the other 33. Some of the correlations are high (e.g., ± 0.60 or greater) and some are low (i.e., near zero). Comparatively high correlations point to that two items are associated and will probably be grouped together by the factor analysis. The researcher agrees to the postulates of Beaumont (2012) and Wuensch (2012) which state that, items with low correlations, for example, $0.3 < r < 0.3$, usually will not have high loadings on the same factor. The researcher managed to extract 11 components from the 34 importance business intelligence measures as shown in Appendix D14. The cumulative variability of the importance measures was **75.571%**, and, the Cronbach α , was **0.912**, which was quite high.

4.3.1 Reliability of Business Intelligence Importance Data Set

The value of Cronbach α , as in Table 4.12, shows that the data set for the BI importance measures was highly reliable and valid. The Total Variance Explained table displays how the variance is distributed between the 34 probable factors. As has been mentioned before eleven business intelligence importance factors have eigenvalues (a measure of explained variance) greater than 1.0, which is a common standard for a factor to be valuable. The research findings concur with Beaumont (2012) and Wuensch (2012), who suggested that when the eigenvalue is less than 1.0 the factor explains less facts than a solitary item would have elucidated. According to the principles of PCA, most investigators would not ponder to include the information obtained from such a factor. Thus, in this study if the researcher did not specify otherwise, the computer then looked for the best eleven-factor solution by “rotating” eleven business intelligence importance factors.

Reliability Statistics: Importance Measures		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.912	.912	34

Table 4.12: Reliability analysis of BI Importance Factors

This researcher agrees with Beaumont (2012), who hinted that the determinant (located under the correlation matrix) should be more than .0001. For this research, the determinant for the observed business intelligence importance measures is equal to 1.971E-11, as a result, this assumption was met. Beaumont went further to state that, if the determinant is zero, then a factor analytic solution cannot be achieved, because this would entail dividing by zero, which would mean that at least one of the items can be implicit as a linear grouping of some set of the other observed items. As mentioned earlier, in the data analysis for business intelligence satisfactory measures, the Kaiser-Meyer-Olkin (KMO) measure should be greater than **0.70** and is inadequate if less than 0.50. The KMO test tells whether enough BI items are predicted by each factor or not. In this research, it is **0.744** and this is greater than 0.70, indicating sufficient BI items for each factor.

In order for the researcher to carry out PCA, the Bartlett test should be significant, that is, a significance value of less than 0.05. This means that the variables are correlated highly enough to provide a reasonable basis for factor analysis as in the research study. The value of significance for the Bartlett's Test of Sphericity for the business intelligence importance measures was 0.000. As shown in Table 4.13, this is significant as it is less than 0.05, alluding to the fact that, the correlation matrix is significantly different from an identity matrix, in which correlations between variables are all zero.

KMO and Bartlett's Test for Business Intelligence Importance Measures		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.744
Bartlett's Test of Sphericity	Approx. Chi-Square	6035.089
	df.	561
	Sig.	0.000

Table 4.13: Measure of Sampling Adequacy and Bartlett's Test for BI Importance Measures

The researcher also looked at the communalities table for the BI importance measures, which represented the relationship between the variable and all the other variables (i.e., the squared multiple correlation between the item and all other items) before rotation. If many or most communalities are low (**< .30**), this entails a small sample size, and is more likely to distort results. In this study, it can be noticed that all the initial communalities are above 0.30, which is good. In this research, the researcher did not specify the number of business intelligence importance factors to be rotated, the computer rotated eleven factors, as seen on the right side of the Appendix D15 under the heading "Rotation Sums of Squared Loadings". The researcher is also plotted the scree plot for the BI importance measures.

4.3.2 Scree Plots for Business Intelligence Importance Factors

The Scree plot in Figure 4.4, shows that after the first eleven components, dissimilarities amongst the eigenvalues decline (the curve flattens), and they are less than 1.0. This again supports an eleven business intelligence importance measures component solution. The Scree Plot shows the initial Eigenvalues. Note that both the scree plot and the eigenvalues support the conclusion that the 34 importance variables can be reduced to eleven components. It is notable that the scree plot flattens out after the eleventh component. The cumulative variance added by the factors and through the use of the following scree plot shows that almost 20 importance measures were reckoned to be appropriate. However, the eleventh component is very poorly defined, relating only to one variable. Thus, one may decide to use only one summary variable, based on all variables except *OBSadopt_1* (User adoption of the business intelligence technology), or to redo the PCA after omitting *OBSadopt_1* (User adoption of the business intelligence technology). Research has shown that, it is customarily best for components to be demarcated by at least four variables (Beaumont, 2012; Wuensch, 2012).

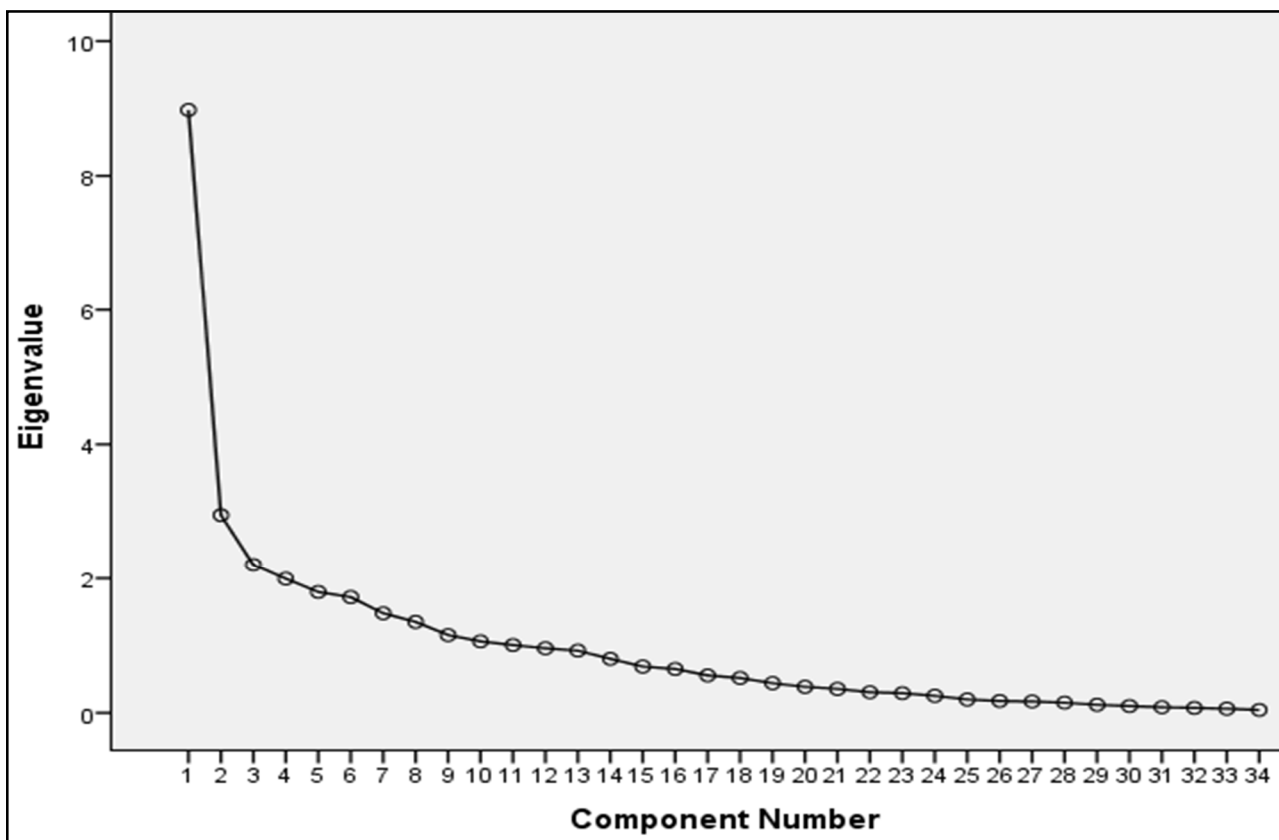


Figure 4.4: Scree Plots for Business Intelligence Importance Factors

4.3.3 Business intelligence Satisfactory Components Plot in Rotated Space

The components plot in Figure 4.5, shows how closely related the items are to each other and to the eleven components. This plot of the component loadings shows that *OBSstratalign_I*, *TSrelations_I*, *OBSdatagov_S* and *OBSdesign_I* all load highly and positively on the first component. Even after rotation, *OBSskills_I* is predicted by its own component, which does not have strong loadings on any of the other variables. This plot of the component loadings shows the default settings used, do not sort the variables in the Rotated Component Matrix by magnitude of loadings and does not suppress low loadings. Thus, the researcher had to manually organize the table and some researchers usually give names to rotated components. This researcher, aggregated the items that had high loadings for each component and used composite variables in the further analysis. The researcher did the same thing with the factor loadings, however, the implication of the latter is that this composite variable is an index of the underlying measured construct. The Component Plot in rotated Space shown in Figure 4.5, gives one a visual illustration of the loadings plotted in a 3-dimensional space.

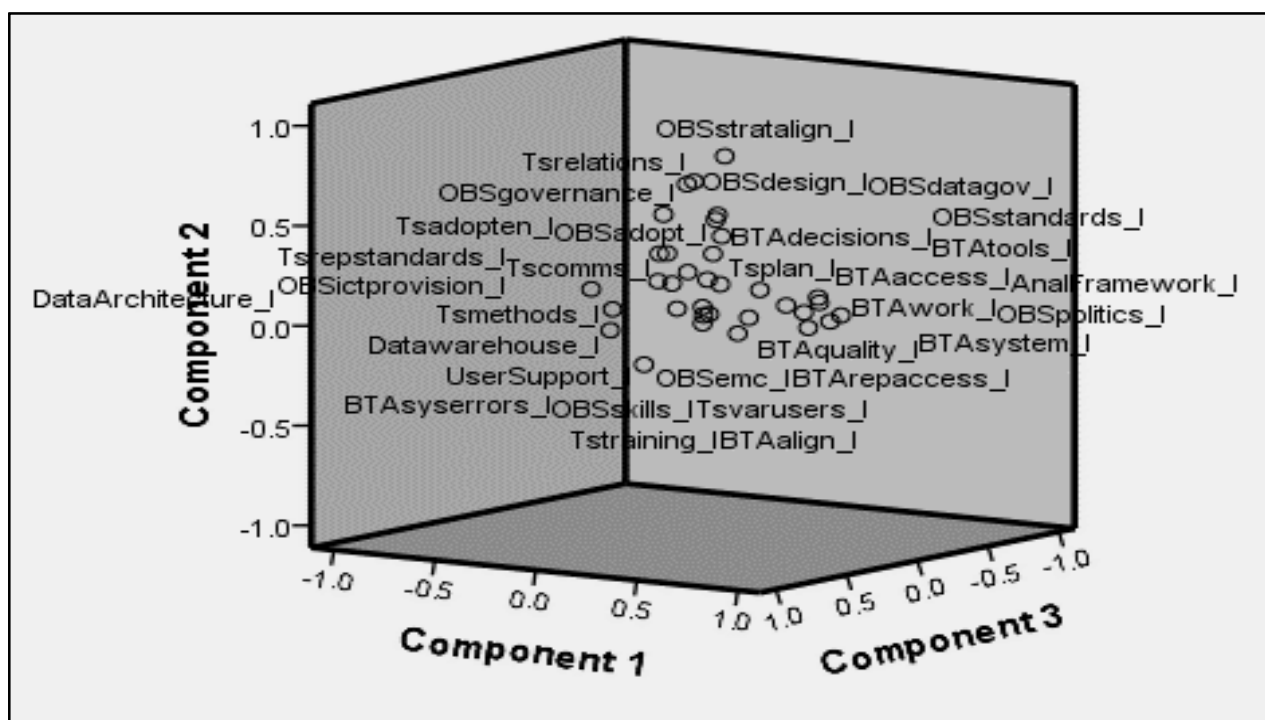


Figure 4.5 Business intelligence Satisfactory Components Plot in Rotated Space

The factors that were loading greater or equal to 0.3, and those less or equal to -0.3 were investigated. The rotated component matrix for the observed importance measures are shown in Appendix D11. The observed importance variables with high factor loadings were recorded. The full complement of the business intelligence dimensions, rotated component

matrix and their reliability and validity using Cronbach's α are shown in Appendix D14. The rotated component matrix, sometimes referred to as the loadings, is the key output of principal components analysis. It contains estimates of the correlations between each of the variables and the estimated components. The research showed moderate-to-strong correlations between the four BI dimensions and component 1. When interpreting component matrix correlations, the correlations of $-0.3 < r < 0.3$ are regarded as being trivial. These correlations are commonly referred to as loadings.

4.3.4 Variance of Business Intelligence Measures Explained

The researcher forced a second PCA for the importance measures to accommodate the 34 factors that were not deemed suitable. The Anti-image correlation matrix for the business intelligence satisfactory measures shown on Appendix D15, shows that the *OBSadopt_I* (User adoption of the business intelligence technology), *TSHETDATAACC_I* (Business Intelligence data quality) and *TSvarusers_I* (Support of a broad range of users) had low variances. Thus, this made the researcher to subject these variables to more scrutiny. The researcher then looked at the eigenvalues for the observed business intelligence importance measures, which when rounded to the nearest whole number were equal to one. These measures were 18 of them, and they had a cumulative variance of almost 91%.

In the researcher's assumption, those observed BI variables or measures that could not create any components, were eliminated. In order to be satisfied with the components themselves, the components should have more than 2 items or variables and do not load on the un-rotated or initial component 1. Hence, the researcher considered all the 34 BI importance measures, as each of the eleven components came as result of two or more observed importance BI measures. The aim of using PCA was to expound considerably the variance of the observed variables as much as possible, by means of a few combined variables (habitually denoted as components). It is important to note that PCA does not distinguish between common variance and unique variance. The researcher concluded that the differences in results decrease as (a) the score reliability of the measured variables increases, or (b) the number of variables measured increases.

The findings from the study agree with those of Wuensch (2012), who found out that, when only a limited variables are being examined or the communality yield small values, PCA processes yield deviating results. In this research, bearing in mind the first research question, recording the percentage of explained variance, and computing, PCA was

appealing since, (a) the percentage of explained variance is a direct measure of goodness of fit in PCA; and (b) it was not obvious how to compute the percentage of explained common variance in other factor analysis techniques. The dataset met situations of 258 observed variables and high communality in which PCA was a suitable approach to analyse the BI components. The main quantitative analysis was seeking to address the first two research questions, RQ1 and RQ2, by providing the pertinent BI factors from the respondents' supposed importance of the BI features and the relevant BI factors for the respondents' supposed satisfaction with the BI characteristics at their institutions.

4.4 Phase III – Qualitative Data Analysis

The data analysis approach this researcher used during the qualitative data analysis phase was content analysis. Context analysis is a flexible method used to analyse textual data. The content analysis approach that was used was basically impressionistic, intuitive, and interpretive in nature. The researcher's approach to content analysis resulted in quantitative data, as will be demonstrated in the next sections. The data that were subjected to content analysis were the open-ended questions from the SAHEIs BI survey, semi-structured interviews and the statutory documentation from DHET. The qualitative content analysis, was done with the assistance of QDA Miner, which is a qualitative data analysis software for coding, annotating, retrieving and analysing small and large collections of documents and images. Qualitative content analysis is defined as, *“a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns”*, (Hseih & Shannon, 2005, p. 1278). The three qualitative content analysis approaches identified by Hseih and Shannon (2005) are: directed content analysis, conventional content analysis and summative content analysis.

Qualitative researchers may perhaps choose to use a directed approach to content analysis, when prevailing theory or prior research is present about a phenomenon. However, the existing theory or research current available for the phenomenon is piecemeal or would benefit from further investigation. This can be classified as a deductive use of theory based on their distinctions on the role of theory, and its key tenets being of the naturalistic paradigm's general approach to the study design and analysis. The objective of a directed approach to content analysis is to authenticate or lengthen conceptually a theoretical framework or theory, argued Hseih and Shannon (2005). The basis of directed content analysis is that prevailing theory or research can assist in focussing the research question.

It can make available estimates about the variables being studied or about their relationships, thus assisting in determining the initial coding scheme or connections between codes.

On the other hand, a summative content analysis commences with distinguishing and enumerating certain words or content in text with the rationale of comprehending the contextual use of the words or content. This quantification, as Hseih and Shannon (2005) puts it, “is an attempt not to infer meaning but, rather, to explore usage.” Manifest content analysis is the term given to the analysis made to quantify the number of appearances of a particular word or content in textual material. If the analysis ceased at manifest content analysis level, then it would be quantitative. This is because it would only be focussing the frequencies or number of occurrences of specific words or content. A summative approach to qualitative content analysis goes beyond frequencies of words or content to include latent content analysis (Hseih & Shannon, 2005). Latent content analysis focus on ascertaining the underlying meanings of the words or the content.

Conventional content analysis is generally used with a study design whose aim is to describe a phenomenon. This type of qualitative content analysis is typically suitable when current theory or research literature on a phenomenon is inadequate. Researchers evade from using predetermined categories instead permitting the categories and names for categories to flow from the data. Researchers engross themselves in the data to permit new discernments to surface, as described in inductive theory development. Many qualitative methods share this initial approach to study design and analysis especially when data are collected primarily through interviews, and open-ended questions. The textual codes emerging directly from the text are insightful of more than one important thought. The codes then are organized into categories based on how they are related and linked. These emergent categories are exploited to arrange and assemble codes into significant clusters. The numbers of clusters are usually between 10 and 15 to keep clusters broad enough to sort a large number of codes (Hseih & Shannon, 2005).

In this study, the researcher had used the conventional and summative approaches to qualitative content analysis to capitalize on their respective advantages. This was in line with the philosophy of employing methodological pluralism, in most of the research tasks. Summative content analysis was unobtrusive and nonreactive to methodological approaches used to design, develop and implement BI systems within the SAHEIs.

Conventional content analysis allowed QDA to determine clusters for the researcher and the researcher subjectively coded these clusters and put them into related categories. Both conventional and summative content analysis approaches provided worthwhile evidence of trustworthiness, and credibility to the qualitative data analysis. A mechanism to demonstrate credibility or internal consistency is to show that the textual evidence is consistent with the interpretation

4.4.1 Content Analysis of BI systems within SAHEIs

When the researcher was looking for distinct concepts and categories in the textual data, generated from the open-ended survey questions, QDA Miner was allowed to do open coding for the researcher. QDA Miner broke down the data into first level concepts, or master headings, and second-level categories, or subheadings. Researchers often use highlights to distinguish concepts and categories. The first open-ended question which the researcher subjected to conventional and summative content analysis was, “what is the Business Intelligence System you are using? If your institution does not have one, please indicate so. ***Hint:** A Business Intelligence Systems is the information system that provides insights into the core business of the university. It may consist of dashboards and reports that can be used for decision-making processes in the institution.*” The following Table 4.14 illustrated the categories, codes, frequency, and number of cases that were analysed through QDA Miner.

Category	Code	Description	Count	% Codes	Cases	% Cases	Nb Words	% Words
INTEGRATOR	ITS	AdaptIT Product	3	1.20%	3	1.20%	3	0.30%
INTEGRATOR	Oracle Discoverer and ITS	Oracle menus, Oracle discoverer	21	8.10%	21	8.10%	165	14.90%
INTEGRATOR	Heda Cognos Infobuilder	HEDA Cognos and Infobuilder	6	2.30%	6	2.30%	15	1.40%
BI NOT APPLICABLE	NO BI SYSTEM	There is no BI AT INSTITUTION	6	2.30%	6	2.30%	12	1.10%
BI NOT APPLICABLE	BI System NOT THERE	There is no BI AT INSTITUTION	6	2.30%	6	2.30%	27	2.40%
MICROSOFT BI	MICROSOFT	Institution Use MS Technologies	33	12.8%	33	12.80%	207	18.80%
INTERNAL	IN HOUSE	Institution develop its own	18	7.00%	18	7.00%	99	9.00%
PROGRESS DATABASE	Based on Progress DB	Reports Based ON PROGRESS DB	9	3.50%	9	3.50%	180	16.30%
POWERHEDA	PowerHEDA system	IDSC's PowerHEDA system	141	54.7%	141	54.70%	147	13.30%
ORACLE	Business Objects	SAP Business Objects	15	5.80%	15	5.80%	249	22.60%
TOTAL			258	100 %	258	100.0%	1104	100.1%

Table 4.14: Content Analysis for BI Systems Used in SAHEIs

The researcher calls upon the reader to look at the 54.7% of the PowerHEDA category, and as the researcher was absolutely convinced to explore further why a quantum of SAHEIs are using the various HEDA versions for their BI systems. This study revealed that there was a hybrid of heterogeneous BI systems within the SAHEIs as shown in Figure 4.6.

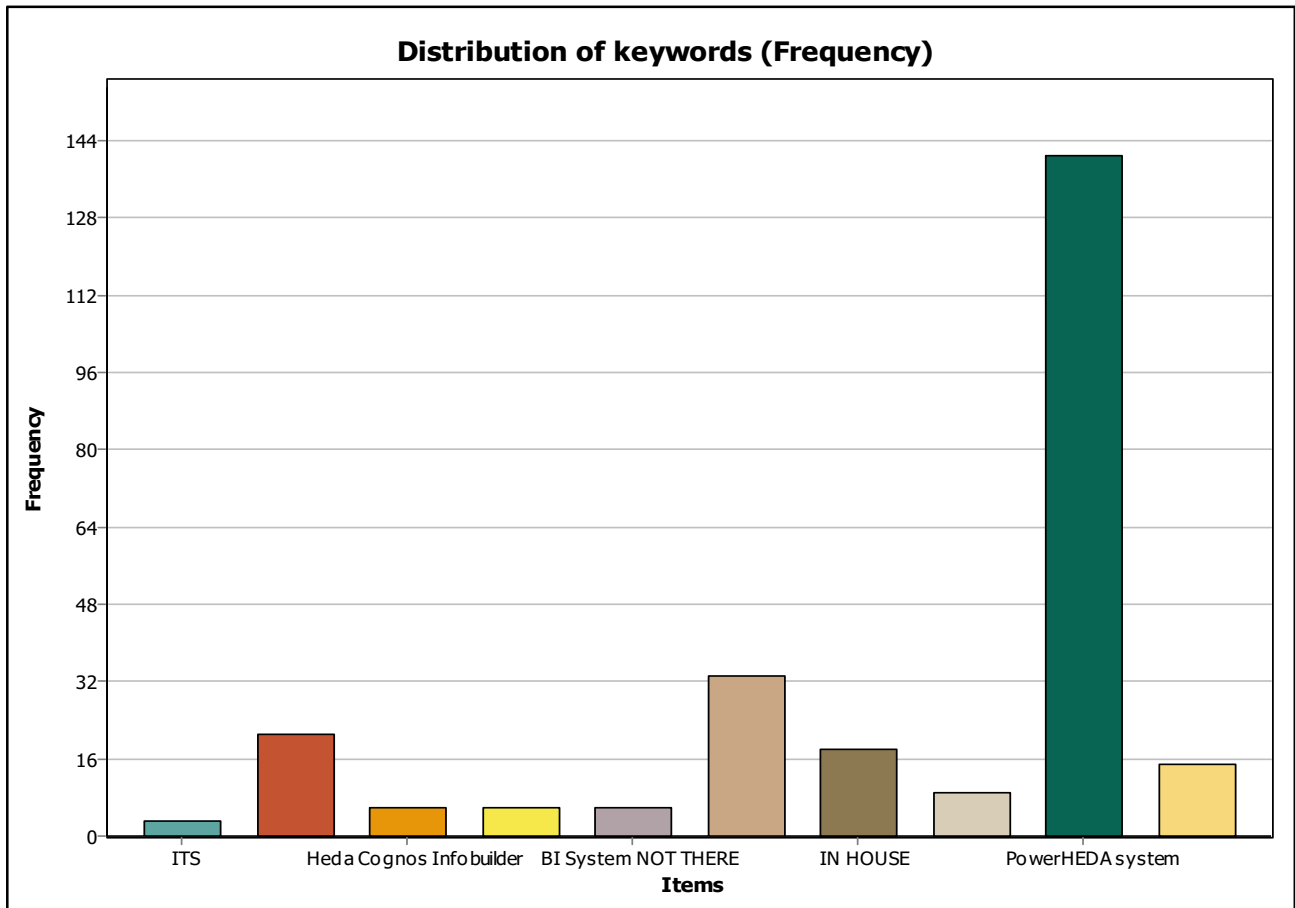


Figure 4.6: Distribution of Key BI systems within SAHEIs

The distribution of key BI systems currently used in SAHEIs is shown representatively using a pie chart as shown in Figure 4.7. The systems range from PowerHEDA, PRIGRESS DB, COGNOS, Infobuilder, Microsoft BI technologies, Business objects and some with no systems at all.

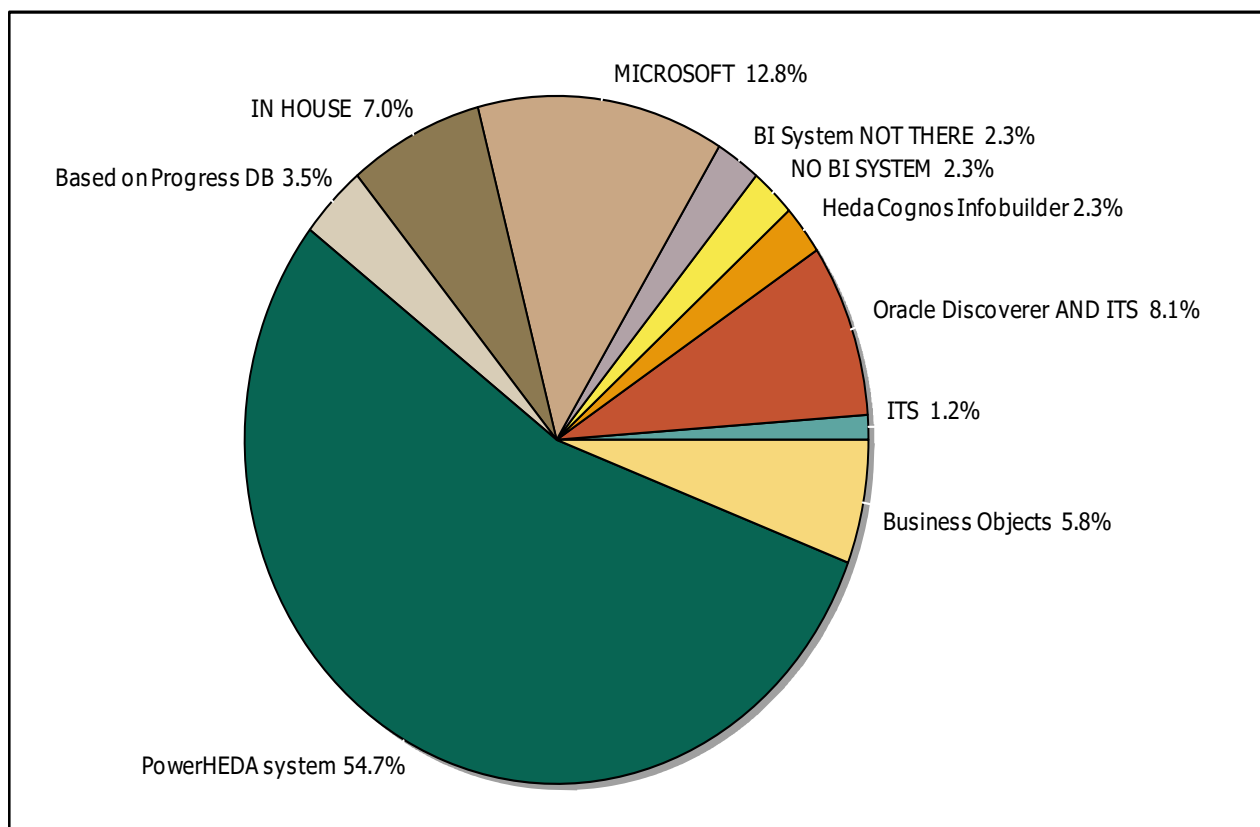


Figure 4.7 : Business Intelligence Systems in SAHEIs

If one looks into the distribution of the research participants who at least mentioned the BI systems, which the researcher had coded and clustered using conventional and summative content analysis, Business Objects appeared more often in the texts. As can be observed in Figure 4.8 the distribution of keywords related the current BI systems being used in the SAHEIs does not correlate to the frequency of use of these systems. It can also be noticed that that some institutions use more than one BI system. The reason for using a hybrid of BI systems might be due to the nature of the various BI contexts catered for by each system. However, this researcher is of the view that multiple systems brings more challenges than benefits.

Multiple systems require data integration, interoperability, demand different skills set, and have different human computer interfaces. It is not incumbent of this study to despise the use of hybrid BI systems within the same institution. However, as will be demonstrated in the CABIF solution architecture, a well-thought data architecture is an important feature.

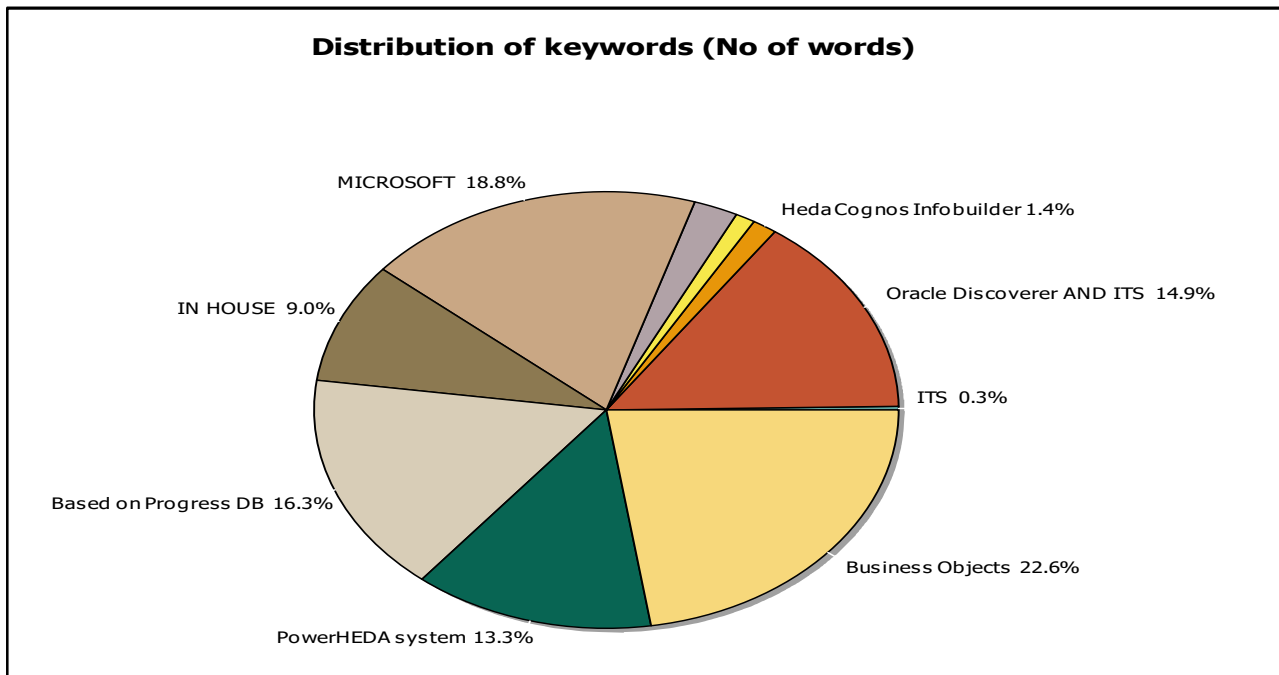


Figure 4.8: Distribution of Key words for BI Systems within SAHEIs

Using the Link Analysis feature within the QDA miner it allowed the researcher to display the co-occurrence of the BI systems within SAHEIs. This feature which is within *Wordstat* plugin of QDA Miner uses force-based graphs, multi-dimensional scaling or circular graphs, to show the links between the codes being used in context analysis. The graphs that the researcher generated using the Link Analysis feature, constituted an interactive way to explore connections between the codes and to retrieve text sections linked with specific connections. In the context of network theory, link analysis is a data analysis procedure used to evaluate relationships (connections) between nodes. The relationships between the codes being analysed may be recognized among different types of nodes, and in the study among the different types of BI systems being used within the SAHEIs.

Figure 4.9 shows the combination of the links of the text related to the BI systems usage data within the SAHEIs. In this study the emphasis was on the link analysis of the BI systems being used with the SAHEIs settings and contexts. The researcher closely integrated the information obtained from both network structure and textual content of the BI systems, in order to produce the highest-quality search results. This researcher concluded that an institution using the HEDA BI system has 77.4% chances of using SQL, 59.5% chances of using Microsoft BI technologies, and 48% chances of developing other home grown BI reports. An institution using ITS Enterprise Resource Planning system has 68.5% chances of using the Oracle database.

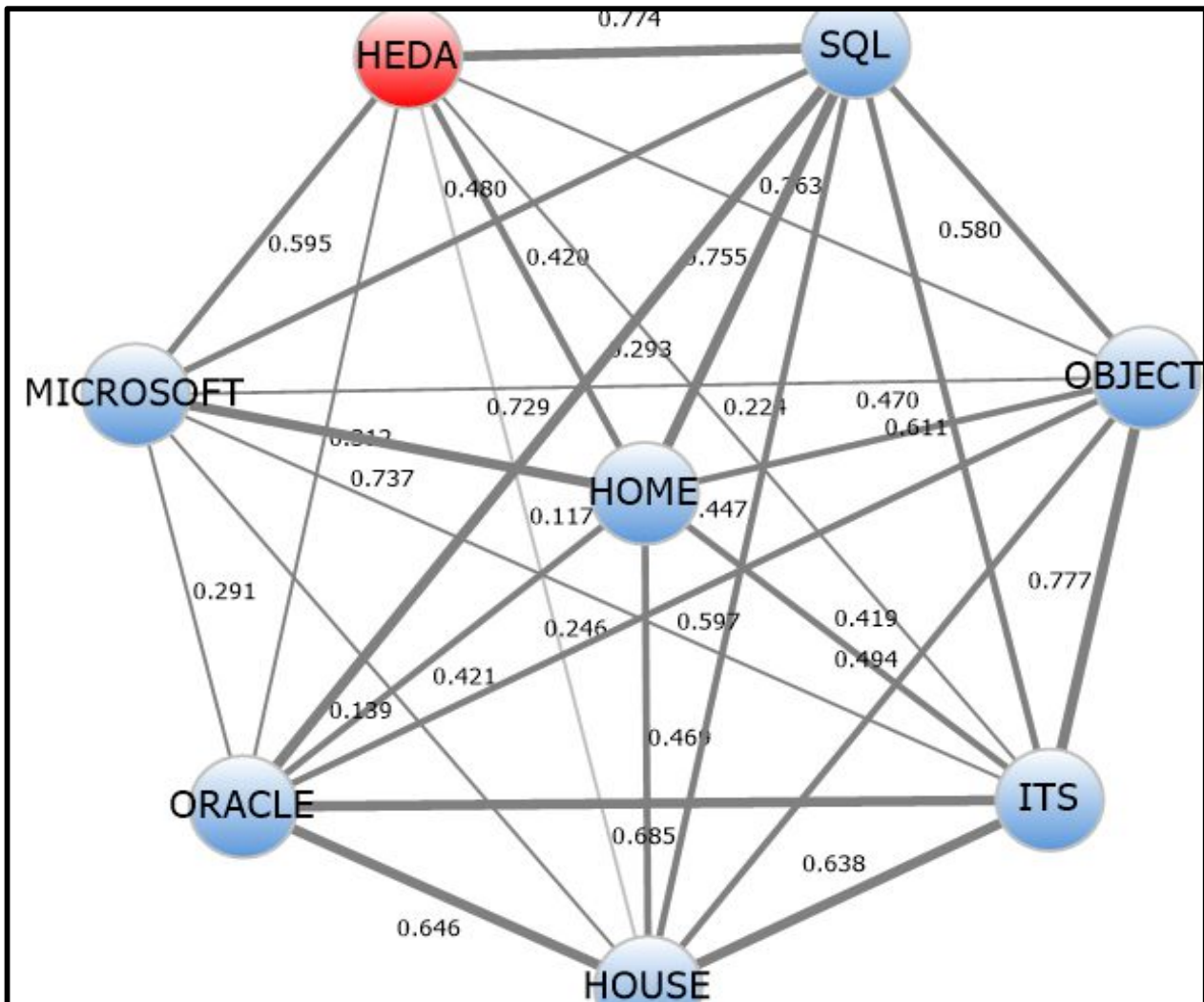


Figure 4.9: Usage of BI systems within the SAHEIs

The network graph for the current BI system that the researcher produced has significant input in determining the likely technological choices that the SAHEIs could opt for. The centrality of home grown solutions in graph is also significant as it is in line with the contextualism paradigm. This researcher subscribes to the view that, independent of commercial BI products available to the institution, customised BI products related to specific institutional contexts are indispensable. The researcher also analysed qualitatively the methodological approaches being used for BI implementations within the SAHEIs.

4.4.2 Content Analysis of BI Implementation Methodology

This study endeavoured to gather information about the business intelligence solutions and methodological frameworks prevailing within the SAHEIs. In line with that quest, the researcher classified the scientific knowledge relating to current BI applications within the

institutions in relation to theories and practices of IS research. The open-ended question that was posed to the research participants within the SAHEIs was as follows: *“What is the probable alternative to the current Business Intelligence System being used at your institution? If you have used any methodology in implementing business intelligence systems within your institution, briefly describe such methodology in the text box provided.”* The researcher developed six categories and 20 codes for the methodological frameworks being used within the sector. These categories and codes were developed after QDA Miner presented the researcher with possible clusters from the textual responses of the previous questions.

Category	Code	Description	Count	% Codes	Cases	% Cases	Nb Words	% Words
AGILE	SCRUM	Agile Development Methodology	9	3.50 %	9	3.50%	27	2.10%
AGILE	Agile Software Development	Agile Software Development Methodology	15	5.90 %	15	5.80%	123	9.50%
SDLC	WATERFALL	Waterfall Using System Development Life Cycle	3	1.20 %	3	1.20%	39	3.00%
SDLC	CONVENTIONAL	Waterfall Using System Development Life Cycle	36	14.1 %	36	14.0%	36	2.80%
SDLC	CASCADE	Information Systems Analysis And Design	9	3.50 %	9	3.50%	36	2.80%
SDLC	SAD	Waterfall Model Using SDLC Principles	12	4.70 %	12	4.70%	108	8.30%
SDLC	SYSTEM DEV LIFE CYCLE	System Development Life Cycle	54	21.2 %	54	20.9%	57	4.40%
SDLC	STANDARD SDLC	SDLC	21	8.20 %	21	8.10%	90	6.90%
SDLC	SAD PROJECT	SDLC	9	3.50 %	9	3.50%	117	9.00%
SDLC	IN HOUSE	In House Reports	3	1.20 %	3	1.20%	30	2.30%
SDLC	Based on User Requirements Specifications	Based On User Requirements Specifications BASED ON SDLC	3	1.20 %	3	1.20%	33	2.50%
COMMERCIAL	VENDOR DRIVEN	Marketed By A Technology Company	21	8.20 %	21	8.10%	60	4.60%
COMMERCIAL	IDSC Marketed	Heda Marketed By IDSC	6	2.40 %	6	2.30%	84	6.50%
COMMERCIAL	Established by SMC to Evaluate HEDA	TASK TEAM Established By SMC To Evaluate Heda	3	1.20 %	3	1.20%	63	4.80%
COMMERCIAL	Followed the Vendor's Presentation	Followed The Vendor's Presentation	3	1.20 %	3	1.20%	24	1.80%
INSTITUTIONAL PLAN	SUBJECTIVE	Bi Reports Developed Based On Institutional Needs	3	1.20 %	3	1.20%	39	3.00%
JAD	SQL	SQL And Joint Application Design	6	2.40 %	6	2.30%	60	4.60%
NONE	No Information	No Methodology Information	21	8.20 %	21	8.10%	51	3.90%
NONE	NOT SURE	The Respondents	3	1.20 %	3	1.20%	24	1.8%
NONE	NO Framework or Methodology	NO Framework Or Methodology	15	5.90 %	15	5.80%	198	15.2%

Table 4.15: Methodologies for BI Implementation within SAHEIs

Using the **WordStat** quantitative content analysis and text-mining plugin for the QDA Miner, the researcher analysed the words and phrases found in the selected BI methodologies code segments. As can be seen in Table 4.15 QDA Miner and WordStat performed simple descriptive analysis and explored in greater details the relationship between words or categories of words the BI implementation methodology variable. The combined 58.3% that mentioned the systems development life cycle (SLDC), as the methodological framework behind their BI systems, can be noted. Although respondents referred to cascade, waterfall, traditional or conventional methodology for designing and implementing BI systems, the researcher classified them under the same category, SLDC. This category had a lot of cases as shown in Figure 4.10.

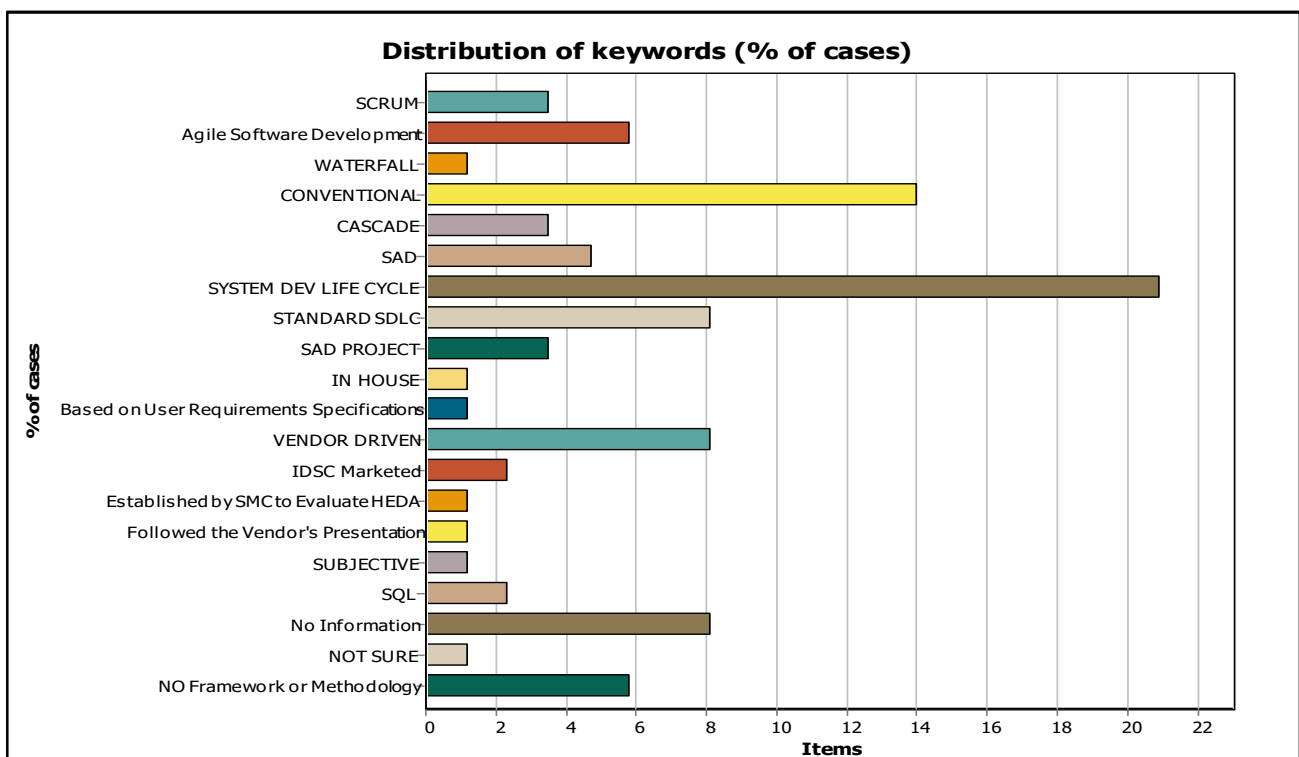


Figure 4.10: Frequency of BI Methodological Terms

This researcher then embarked on a process of searching for relationships amongst coded the methodological elements. In fact, the BI implementation methodological codes consisted of conceptual models of relationships that theoretically related substantive codes to one another. The researcher authenticated the findings of the methodological frameworks for BI systems within the SAHEIs, based on the results of context analysis of the semi-structured interviews data. As an example, the researcher managed to clearly cluster the BI methodological frameworks into Agile, SDLC, and vendor driven, subjective and with some institutions not having any methodology at all.

To illustrate the results obtained from the field, one interviewee mentioned that they don't even know if any methodological framework was followed in the implementation of the HEDA system. The HEDA system was implemented at the institution, after a presentation was done to the Senior Management Committee (SMC). The committee then formed a Task team, which recommended HEDA to the SMC. Although the researcher did not obtain the recommendation documents presented to the institution, the researcher thought that the process, was not bound by standard IS development approaches. The exploration of keywords which led to the coding of the existing BI methodological approaches within SAHEIs are represented in Figure 4.11

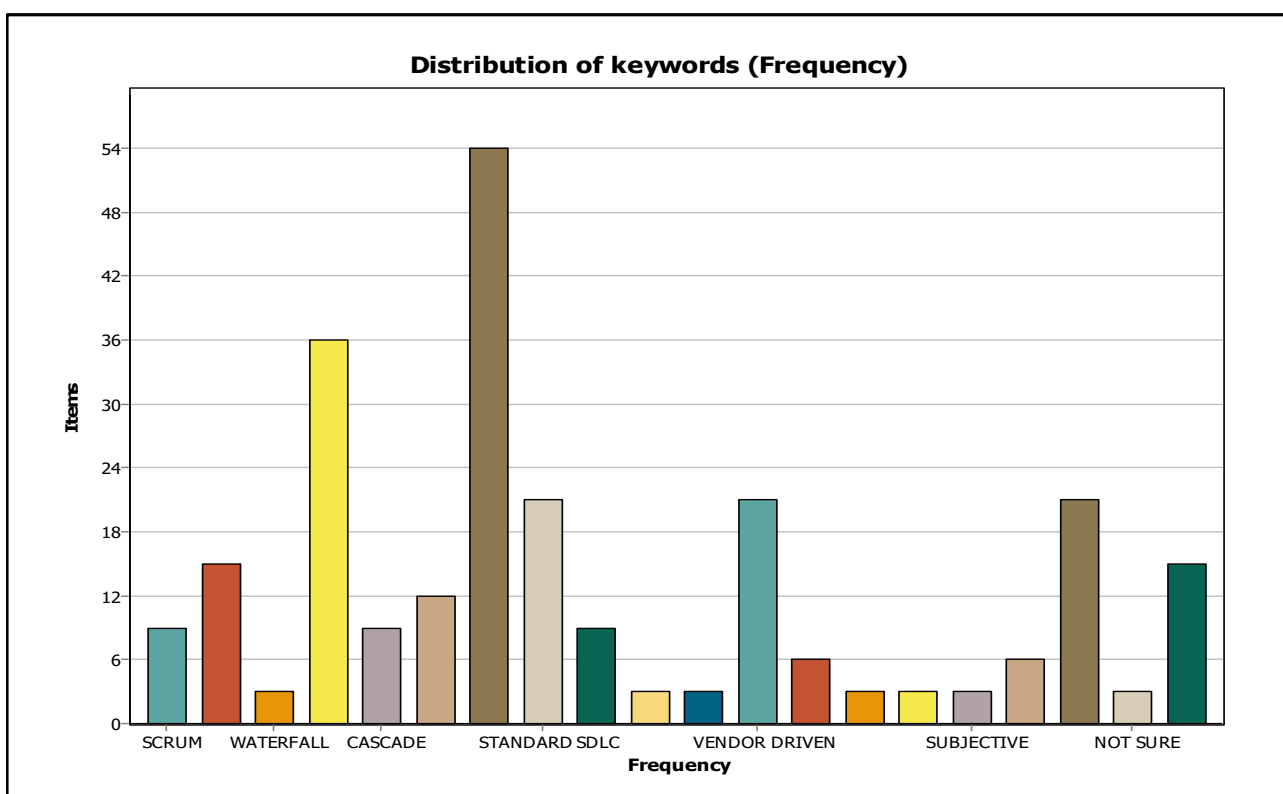


Figure 4.11: Distribution of key BI Methodological Terms within SAHEIs

The SLDC with a frequency of 21.2%, was shown through conventional and summative content qualitative analysis techniques as the main methodological framework. The SLDC, also denoted to as the application development life-cycle, is a term used in systems engineering, information systems and software engineering to articulate the processes for planning, developing, testing, and deploying an information system within an organization. The description of SLDC, implies that there are still various approaches that can be used to develop BI systems within the SAHEIs.

In real terms, an institution might decide to use the objected-oriented design, development and implementation of BI systems, they might use the rapid prototyping techniques, build and fix models, incremental development techniques or the agile software development techniques. This researcher's decomposition and disintegration of the SLDC showed that there is a void of theoretical and practical foundations of BI design, development and implementation within the SAHEIs. The researcher authenticated these findings in Figure 4.12, by presenting the results of the summative content analysis of the research participants' BI methodological views.

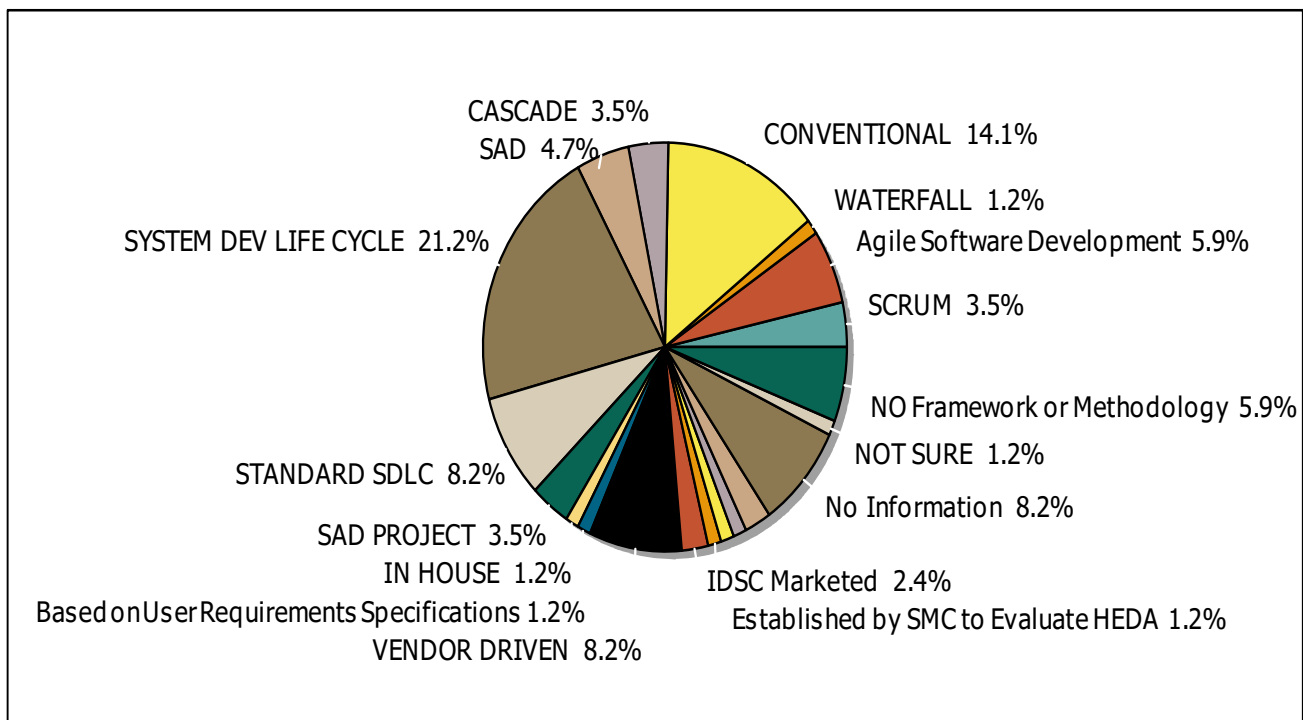


Figure 4.12: BI Methodological Views within SAHEIs

The qualitative data analysis shown in Section 4.4 reveals that different research purposes require different research designs and data analysis techniques. The qualitative strand of this study used conventional and summative approaches to content analysis. These approaches to the analysis of quantitative data showed the power they have in matching the specific research objectives and the state of science of the BI domain within the SAHEIs. The researcher managed to draw up the key importance of methodological pluralism opted for in this study. Although in this section the researcher has not shown how the statutory documents were analysed, these were covered during the elicitation of the procedural and prescriptive knowledge of BI during the DSR phase. The qualitative phase of this research highlighted some methodological gaps of BI design, development, testing and implementation in SAHEIs.

4.5 Theoretical Foundations of BI Systems in South African Higher Education

The first two research questions solicited the researcher to look for the conceptual foundations behind the BI systems currently being used in the South African higher education. The survey items that were answered by 258 respondents from the South African higher education gave an insight on the theoretical foundations of BI in the South African higher education. The 258 respondents came from 17 of the 26 public South African public universities, which gave the researcher the ethical clearances to carry out the research. It is important to note, that the researcher signed a condition of anonymity with every institution, hence did not mention the university where the respondents came from. The list of universities that issued ethical clearances are in the Appendix F1. The research questions which were being investigated in the first part of the research were the following:

RQ1 *What are the conceptual foundations of the business intelligence frameworks currently used in the South African Public Higher Education Institutions?*

RQ2 *Are these Business Intelligence technological entities theoretically and practically contextualised?*

The previous section had shown that, the 34 observed variables subjected to PCA varimax rotation, managed to extract five components from the BI satisfactory measures, and eleven components from the BI importance measures. The researcher also found out that two or more variables formed the components that were loaded in each run of the PCA, which was performed.

4.5.1 Business Intelligence Systems Used in South African Higher Education

The study shows that, of the 17 universities where the respondents of the survey came from 14 of them, representing approximately 61%, are using the Higher Education Data Analyser (HEDA), as their Business Intelligence system. The responses obtained from the survey question, “*What Business Intelligence Systems are you using? (If you do not have the Business Intelligence System please indicate)*”. The responses to this question as shown in Table 4.16, were that of the 258 respondents, 153 (59%) use PowerHEDA; 39 (15%) use Microsoft BI technologies; 30(12%) use ITS and Oracle Discoverer; 20(8%) use In-house BI development; 10(4%) use Oracle BI Suite and 6(2%) have no BI system at all at their institution.

BI Technology	Number of Respondents	Percentage
PowerHEDA	153	59%
Microsoft Technologies	39	15%
ITS and Oracle Discoverer	30	12%
Oracle BI Suite	10	4%
In-house BI development	20	8%
No BI System	6	2%
Total	258	100%

Table 4.16: Business Intelligence Systems Used in South African Higher Education

4.5.2 BI Development Approaches in SAHEIs

The findings from the study also show that universities vary in the way the BI systems, are conceptualised and developed within each institution as shown in Table 4.17. The methodological framework or approach that was quite evident was the System Development Life Cycle (SLDC). The other BI design, development and implementation methodologies that came out include agile development approach, conventional waterfall/cascade model to develop the BI systems, SQL programming, and vendor driven approaches were evident.

METHODOLOGY	NUMBER OF RESPONDENTS	PERCENTAGE
SDLC	40	15.5%
AGILE	24	9.3%
Waterfall/Cascade	22	8.5%
SQL Programming	30	11.6%
Vendor Driven	51	19.8%
No Approach	91	35.3%
Total	258	100.0%

Table 4.17: BI Development Approaches in South African Higher Education

The pie chart, Figure 4.6 and Table 4.17 show that System Development Life Cycle (SLDC) constituted 15.5% (40 out of 258); agile development approach 9.3% (24 out of 258); conventional waterfall/cascade model 8.5% (22 out of 258); SQL programming 11.6% (30 out of 258); vendor driven approaches 19.8% and 35.3% (91 out of 258) do not have any methodological approach to implement BI systems at their institutions.

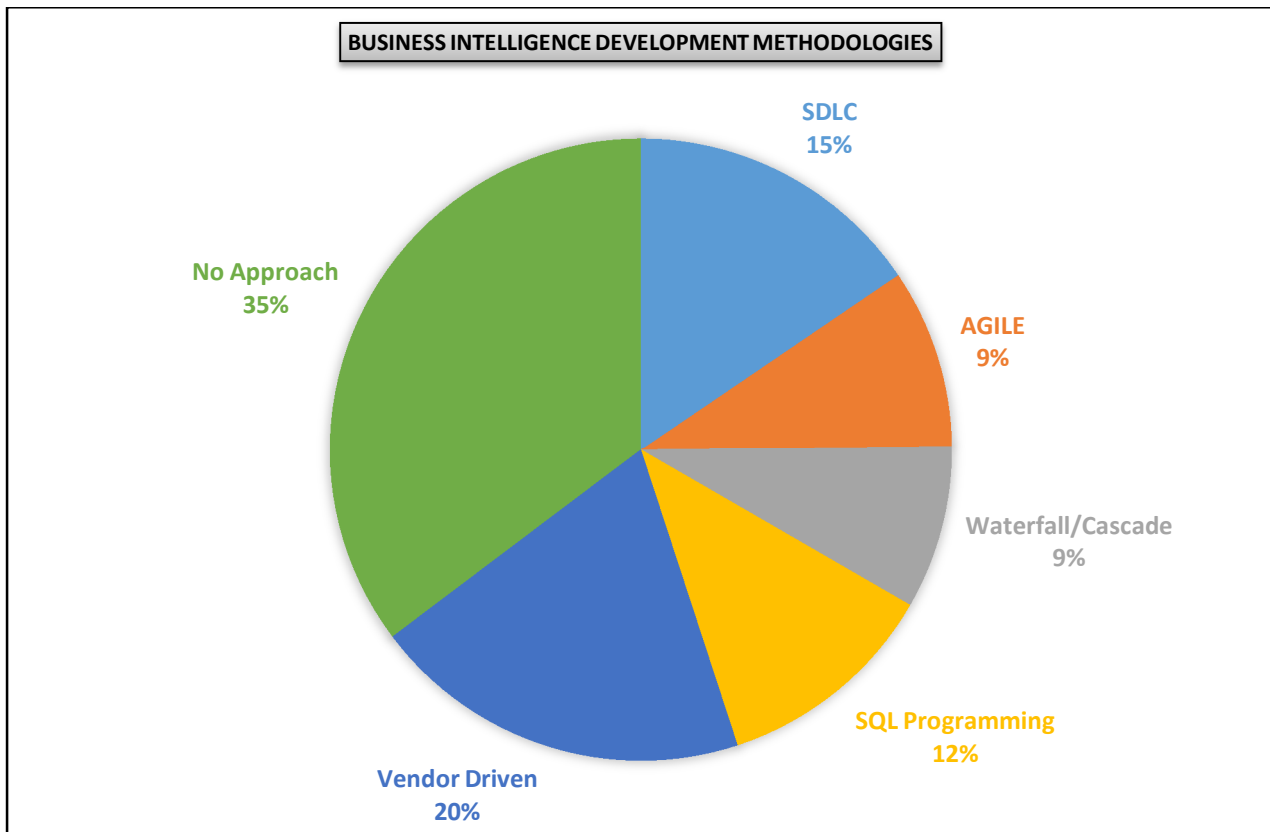


Figure 4.13: BI Development Methodologies in South African Higher Education

The high number of respondents who indicated that they don't have any methodological approach to design, develop and implement BI system at their institution is worrisome. The fact that 19.8% of the respondents indicated that they depend on BI software vendors is also an area of concern. There is no single and coherent approach to implementing and rolling-out BI systems within the South African higher education. As can be seen from the results, the survey item that asked the respondents' knowledge of any methodology used in the BI implementations at their institutions produced varied responses. One respondent at one institution said that *"No we only followed the Vendor's presentation"*. The other respondent indicated that, *"From what I know it was IDSC who marketed their product and we motivated for HEDA to be acquired"* and the other respondent from the same institution wrote, *"We did not follow any framework or methodology the HEDA implementation was based on a presentation from the Vendor"*. A respondent from the same institution with the previous respondents said, *"The implementation of HEDA was not based on any framework or methodology"*.

While answering the same question a respondent from another institution said, *"I have no information regarding this what I know is that a task team was established by SMC to evaluate HEDA"*. As 35.3% of the respondents did not know of any methodological

framework that was used to BI systems at the institution. This researcher concluded that, there is no concrete theoretical and practical means of establishing BI systems within the SAHEIs.

4.5.3 Respondents' Satisfaction with BI in the South African Higher Education

There is no a single coherent business intelligence framework within the South African higher education, but as shown in Table 4.19, a total of 195 respondents out of the 258, were satisfied with their business intelligence systems. Most of these respondents came from the institutions that have the HEDA system as their BI system. What made the researcher more curious, is that the implementation of HEDA within these institutions had been driven by the Vendor, not from a theoretical and contextualised framework. The following Tables, and the pie chart shows that the majority of the respondents were satisfied with their current BI systems.

<i>Variable</i>	<i>N</i>	<i>Mean</i>	<i>Std Dev</i>	<i>Minimum</i>	<i>Maximum</i>
<i>Current_BI</i>	258	4.06	.49	3.00	5.00

Table 4.18: Descriptive Statistics for Current BI Systems

The 76% satisfaction of the respondents with the BI systems at their respective institutions did not bear much value for the research.

Current BI Systems within the Institution					
<i>Value Label</i>	<i>Value</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cum Percent</i>
Unsatisfied	3	24	9.30	9.30	9.30
Satisfied	4	195	75.58	75.58	84.88
Very Satisfied	5	39	15.12	15.12	100.00
<i>Total</i>		258	100.0	100.0	

Table 4.19: Respondents' Satisfaction with current BI System

The statistics shown in Figure 4.13 can be misleading. The fact that there is no BI standard being followed or being adopted by the SAHEIs, was paramount to the researcher. This defragmented theoretical and conceptual foundation of BI systems in the SA higher education, was the gap that the researcher needed to fill with this research.

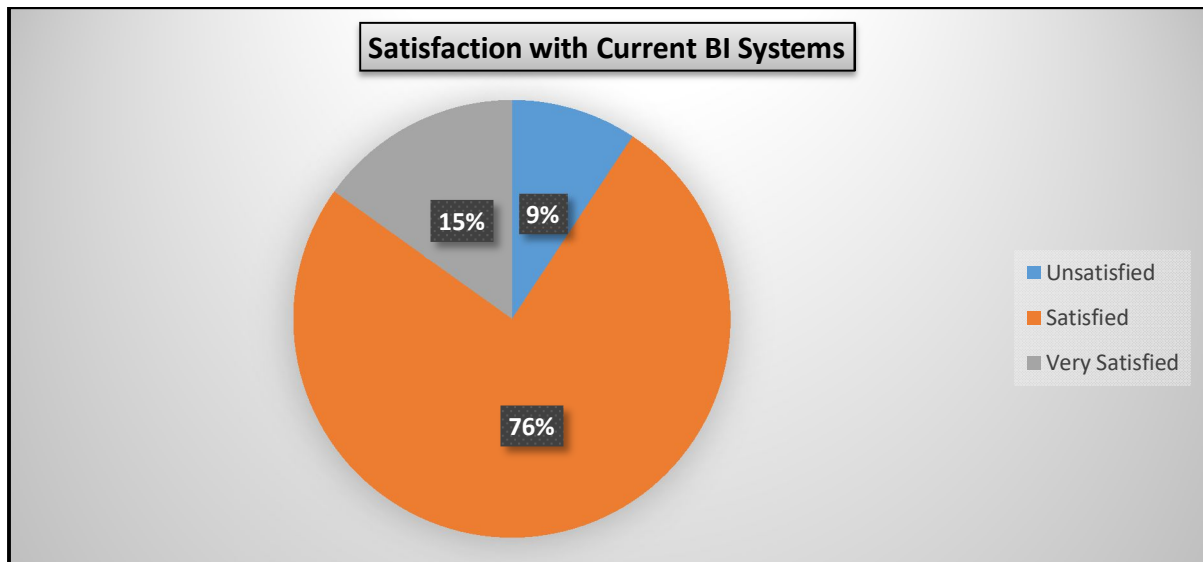


Figure 4.14: Respondents' Percentage Satisfaction with current BI System

This researcher tried to fill in this theoretical and practical gap in the SA higher education domain by using mixed research methods, and these were DSR and PCA. The next section details how this researcher started the construction of the theoretical foundations of BI systems in the SA higher education institutions.

4.6 Construction of Theoretical Bases for BI Systems in SA Higher Education

The final results from the main quantitative data suggests that the researcher needed a conceptual framework for the business intelligence systems in SAHEIs. As has been mentioned before the PCA with varimax rotation was conducted to assess how the 34 BI variables could be clustered, to form the basis of such a framework. The 34 variables shown in Appendix D3, were grouped into four BI dimensions, and each dimension which constituted the latent variables could not yield meaningful results if analysed separately. In the principal data analysis that the researcher did to the 34 observed variables, the researcher intentionally took the results from the PCA of the respondents' satisfactory measures. Five components were extracted from the satisfactory measures and subjectively, the researcher gave a theory or a practice from the results by looking at which observed variables loaded on which component.

4.6.1 Conceptual foundations from Business Intelligence Satisfactory Measures

Thirty-two satisfactory measures as shown in Figure 4.15 loaded on the first component spanning all the business intelligence dimensions that the researcher had defined.

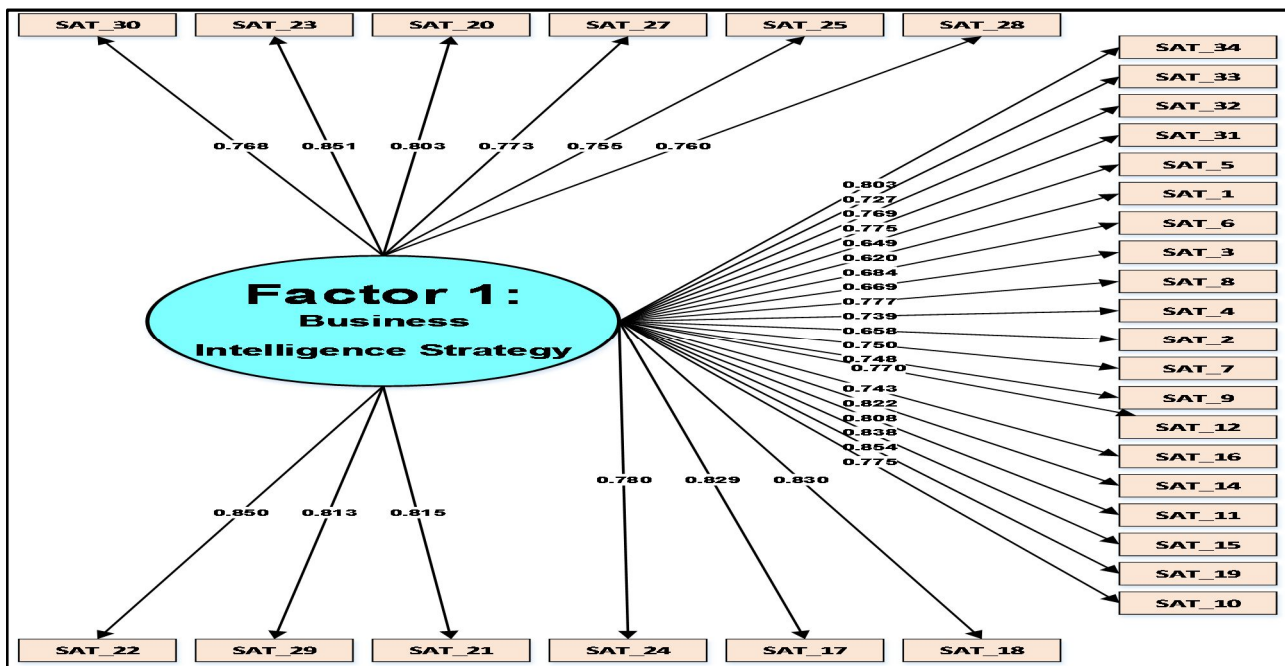


Figure 4.15: Business intelligence Strategy BI Satisfactory Factor Loading

This researcher coded both the observed BI satisfactory and importance measures, clearly defined in Appendices D4 and D3 respectively. The rotated component matrix assisted the researcher in interpreting what these components represented. Thirty-two of the observed satisfactory variables loaded with a variance above **0.35**. These 32 of the 34 observed satisfactory variables that loaded on component 1 formed a subjective factor named **“Business Intelligence Strategy”**. The researcher thought that the scope of this factor should always take into consideration the changing core business needs of the institution. BI should always found itself aligned to these changes in the institution.

The BI satisfactory Component 2, named **“Institutional demand for analytics”** had 13 observed satisfactory variables that loaded on it as shown in Figure 4.16. Thirteen of these variables had correlation values of magnitude greater than 0.30, and subjectively named this factor institutional demand for data, information and analytics. The researcher was prompted by the fact that the respondents saw the value of technology and business alignment, the role of BI in supporting decision making processes, and executive management support. This shows how BI systems turn data into actionable information, and why data analysis makes BI system critical within the institution.

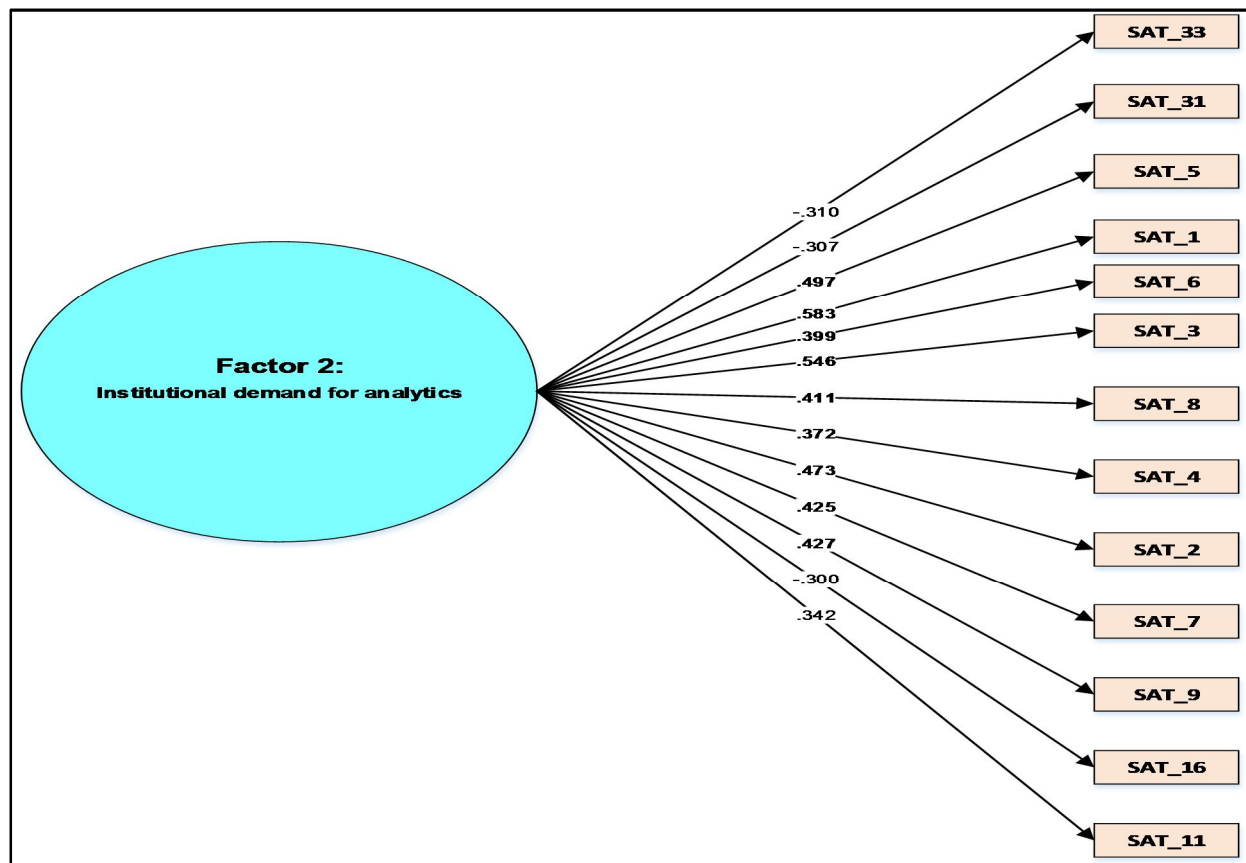


Figure 4.16: Institutional demand for analytics BI satisfactory factor loading

The third satisfactory component as shown in Figure 4.17, had 9 satisfactory variables that loaded on it, having correlations of magnitude of 0.3 and above. The component matrix yielded the correlation values between an individual observed satisfactory variable and a particular factor. In this study, the researcher looked for the highest correlation numbers and grouped these, and subjectively gave a name to the factor. The name was given based on BI literature and the various combinations of the variables as obtained through the literature. These combinations obtained from the responses of the 258 research participants, assisted the researcher to establish that these were the BI theories and practices they were satisfied with. The third factor was subjectively named “**Business Intelligence design, development implementation**” because, most of the observed variables that loaded on this component dealt with the methodological and strategic approaches to design, develop and implement BI systems.

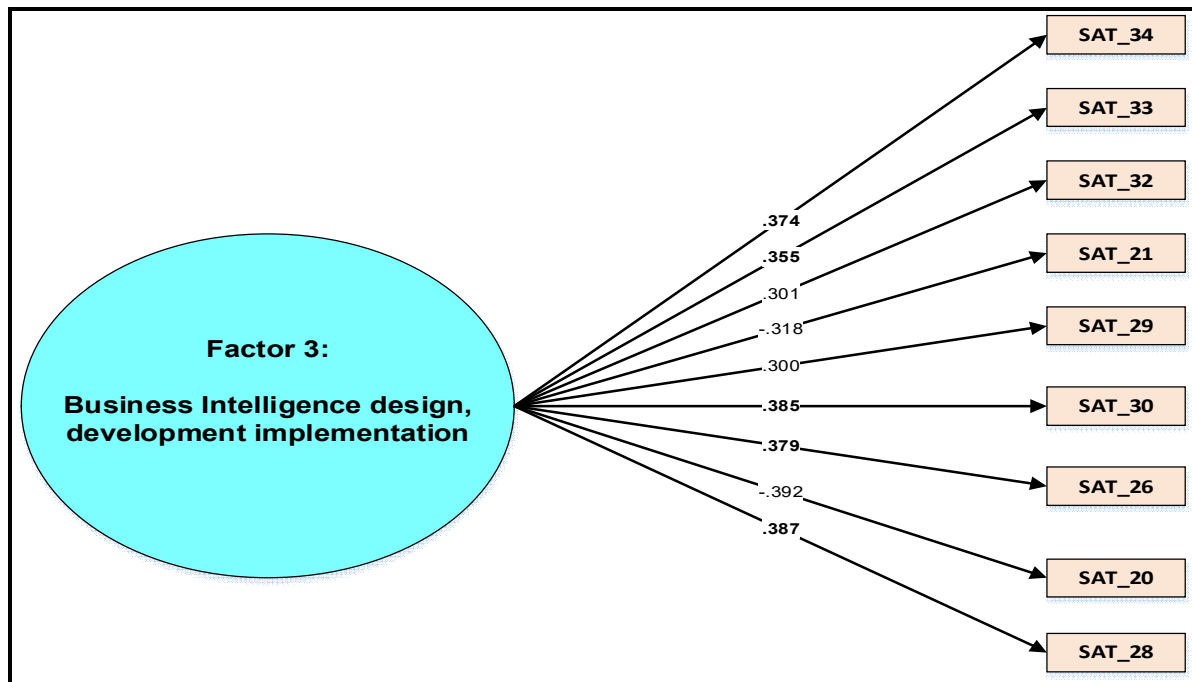


Figure 4.17: BI design, development implementation Satisfactory Loadings

The fourth component was just loaded on by two factors. The theory of PCA does not allow the researcher to further analyse a factor that has less than three observable variables loading on it. Although the two observed variables yielded high correlations values with the fourth BI satisfactory factor, the research did not proceed with subjectively giving a name to the fourth component.

The fifth and final component which the researcher subjectively named “**people, business processes and institutional politics**” was loaded on by four observed satisfactory variables. The variables that loaded on this factor are shown in Figure 4.18. This research agrees with Sherman (2015), who argued that when it comes to the development and implementation of BI systems within organizations, people, business processes and organizational politics are the stickiest of BI project matters. Although, technology has been found to be easy as there are a multitude of vendors that have various products, it is the people that provide major obstacles in BI implementations. The relationship between IT and institutional core business processes and groups, is fundamental for the success of BI systems. The training for business users and IT people provides a firm foundation for data governance, hence making it possible for data to be transformed into actionable information.

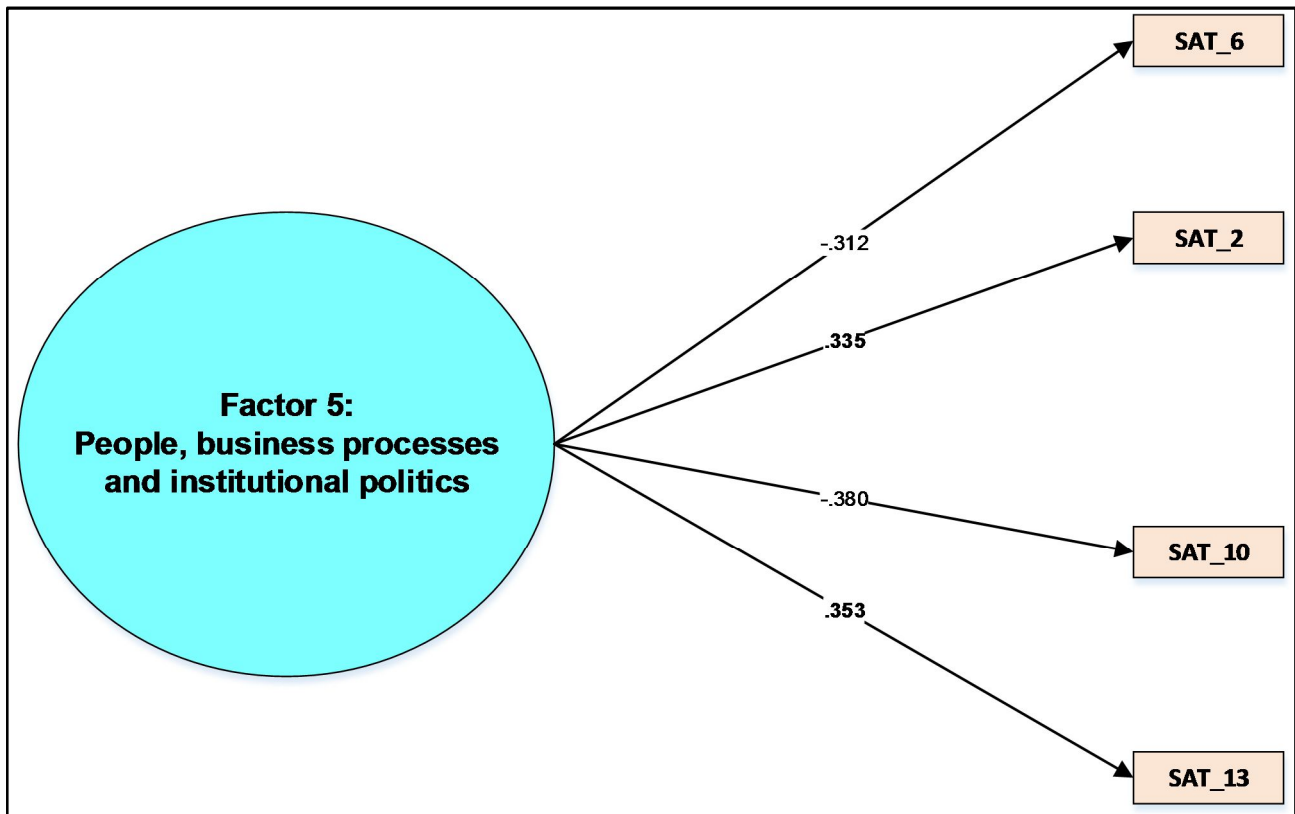


Figure 4.18: People, business processes and institutional politics BI Satisfactory Loadings

4.6.2 Concluding Remarks from Business Intelligence Satisfactory Measures

The fact that the researcher managed to extract only five factors from the 34 satisfactory business intelligence measures indicated the defragmented conceptual foundations of BI within the South African higher education institutions. However, it is with great interest that the researcher managed to get more than 30 observed satisfactory variables loading on components 1, 2 and 3. This gave an impetus to build a BI framework, which is linked to the sector. The satisfactory measures only gave the respondents' satisfaction levels with current BI systems, including the BI theories and practices but could not give any guidelines to generate the BI theories and practices suitable for the sector. The researcher then leaned on the respondents' opinions on the importance of the BI characteristics established in the survey items. This researcher argues that, if a user indicates a BI characteristic as important, it should be included somehow in the framework to be developed.

As has been mentioned in the data analysis earlier the BI importance measures yielded eleven components, which were subjectively named. The importance measures together with other knowledge gathered from the SA higher education, assisted in building the context-aware BI framework for the sector. The BI factors that were generated subjectively derived using the design science research principles. The researcher included the BI

dimensions, variables and their characteristics to DSR in order to come up with a suitable CABIF for the SAHEIs. The next section shows how the knowledge obtained from the PCA and other knowledge, concepts, models, instantiations, were subjected to DSR to produce a CABIF.

The first research question required the researcher to explore the conceptual foundations of the BI frameworks currently used in the South African public higher education institutions. It is this researcher's view that, a well-presented BI framework with a detailed theoretical foundations and sound methodological approaches, gives direction to a well-designed BI solution. Accidental BI architectures should always be avoided, because it shows that BI within the institution was established without any plan. The BI architecture should also include an information architecture, which clearly elucidates the institutional core business contexts. The BI architectural framework should also embrace the data architecture which is vital in the alignment of all institutional data assets, with its core business. It is important to note that the analytical data architecture is also involved within this factor.

Chapter 5 : Design of the Context-aware Business Intelligence Framework

In this chapter, the researcher demonstrates how the results of PCA, were coupled with procedural and prescriptive BI knowledge from the SA higher education in order to come up with the CABIF. Thus, the researcher turned to the six steps of design science research to develop the CABIF. However, the last two steps of DSR, which are the implementation and evaluation of the artefact, in this case CABIF will be demonstrated in Chapter 6.

5.7.1 Introduction to the Implementation of Design Science Research

The analysis of the satisfactory measures assisted in conceptualizing the currents status of business intelligence within the South African higher education. However, in order to build the context-aware business intelligence framework for the sector, the researcher combined the results of BI satisfactory measures with the importance measures of the business intelligence within the SAHEIs. The PCA subjected to the observable importance measures was subsequently exposed to design science research. Design science research in the field of information systems (IS) encompasses the “*constructs, models, methods, and instantiations*”, matching a main concept in the IS domain (Goes, 2014; Myers & Venable, 2014). Design science research is proactive as it seeks to solve a problem, knowledge creation and bring about innovation in the IS field (Goes, 2014; Gregor & Hevner, 2013). This entails that design science research is also about the assessment and determination of the utility of technology and information technology based systems (Goes, 2013; Gregor & Hevner, 2013; Myers & Venable, 2014).

The development of the context-aware business intelligence framework was guided by the paradigm of problem solving, as mentioned in Chapter 3. It is a paradigm that deals with presenting a BI framework that has defined constructs, theories, models, methods and instantiations suitable for the South African higher education sector. This has been achieved by thoroughly examining the problem domain, the maturity of business intelligence solutions and the maturity of the BI solution spaces in the South African higher education sector. Design science research was applied as a means to respond to the following research question:

RQ3 *What Context-aware business intelligence framework is suitable for the South African public higher education sector, and why?*

The researcher applied design science research in deriving the common entities within the SAHEIs, then developed and bring forth a contextualised business intelligence framework for the sector. The research that helped in building the CABIF is actually grounded, principally, in the theoretical underpinnings behind BI systems as reflected by the PCA analysis of the BI observable measures, the common core business attributes in South African higher education, context-aware and information systems. In pursuit of answering this research question the researcher included, studying documentation related to management information systems from the South African higher education sector, including their statutory and legislative obligations. The data collected during the process of answering the first two research questions did provide an insight on how a context-aware business intelligence framework for the sector could be developed. The roles of knowledge in design research in information systems also provided the researcher with a research conceptual framework for the design and development of the CABIF.

Gregor and Hevner (2013) proposed a solution-to-problem framework for design science research where one can really understand the contributions to knowledge by exploring the novelty of the problems and their respective solutions. In order to understand the nature of the connection to theories of BI systems in South African higher education, and design science research, the researcher adapted the design research conceptual framework developed by Gregor and Hevner (2013). The framework emphasized the roles of knowledge in design science research, and it elucidates that a design science research artefact is generated against the background of a body of descriptive knowledge about a problem domain. Goes (2014) indicated that the artefact itself will also encompass and will produce knowledge which might be in the form of “*constructs, models, methods and instantiations*” that may or may not lead to design theory.

The general recipe to develop an artefact through design science research as publicised by Gregor and Hevner (2013) follows the following steps:

- i. *Introduction with precise articulation of purpose and scope of the artefact.*
- ii. *Literature review section with relevant descriptive knowledge and prior prescriptive knowledge.*
- iii. *Method section where research rigour is fundamental.*
- iv. *Artefact description.*
- v. *Evaluation*
- vi. *Discussion and Conclusions* (Goes, 2014, p. vi)

The researcher will discuss how the recipe for design science research was employed in the next section. In this research the evaluation, discussions and conclusions regarding the deployment of the CABIF this researcher developed, has been incorporated in the case study at the University of Venda. This researcher made sure that the validation and evaluation of the CABIF in a South African higher education context, was executed as proposed in the mixed methods research approach, advocated as the basic research design paradigm for this study.

5.7.2 The development of the Business Intelligence Framework

The purpose of this section is to elucidate how the context-aware business intelligence framework for the SA higher education sector was developed. As mentioned earlier, the point of departure was the results of the PCA of the business intelligence measures. In this research, the researcher assumed that, the respondents' value of the BI characteristics was measured by the BI importance measures. The researcher subjectively derived eleven BI importance factors, as was with the five satisfactory measures. In this case, the researcher was building the base for an important BI artefact, within the SA higher education sector. The researcher also complemented the development of the CABIF with the knowledge from statutory requirements for the SA higher education. In the next sections, the researcher will actually show how the CABIF was designed, and developed, based on the correlation values which were obtained from the PCA.

5.7.3 Purpose and scope of the Context-aware Business Intelligence Framework

Business intelligence systems have become important part of the solutions to providing higher education institutions with vital information for reporting and decision-making. The commercial sector has seen a proliferation of BI maturity models or frameworks, and as has been discussed in the literature review (see Chapter 2), higher education is lagging behind in having specific BI maturity models. This study realised the disparities in the adoption and implementation of BI systems within the SAHEIs. This researcher therefore developed a BI artefact, which lens through various contexts within the sector, and named this a context-aware business intelligence framework.

The CABIF tries to capture, generalize and simplify various complex SA higher core business contexts with a reasonable amount of accuracy and situational interpretation. The CABIF deviates from the BI maturity norm, by delving into different generic core business

aspects of the SA higher education and try to unambiguously contextualise and abstract BI instantiations, models, knowledge and theories. The support of managerial decisions based on BI systems depends on good and relevant data from the various institutional data assets. In the next section, the researcher summarises some key knowledge from the sector, and show how to compliment this knowledge in order to come up with a suitable BI Framework for the sector. The literature review that was done in the DSR phase of this research, assisted in contextualising the problem domain and to connect design science activities with the knowledge base of scientific foundations.

5.7.4 Literature Review of Descriptive Knowledge and Prior Prescriptive Knowledge

The researcher was motivated by the desire to improve the design, acquisition, development, and implementation processes of BI systems within the SAHEIs. As Gregor & Hevner (2013) argued, the first issue to consider in DSR is to comprehend the activities of consuming and producing knowledge. The descriptive knowledge denoted by Ω , is the “what” knowledge about natural phenomena and the laws and regularities among the phenomena (Gregor & Hevner, 2013). The literature covered in Table 4.20, deliberates on the descriptive knowledge that was gathered from the SA higher education sector, which contributed immensely in enriching the CABIF.

The literature in Table 5.1, also describes the legislative framework that governs how institutions develop and implement qualifications, the funding structure, the reporting requirements to the DHET, and the national imperatives for higher education. The prescriptive knowledge denoted by λ , Gregor & Hevner (2013) stated that it is the “how” knowledge of human-built artefacts. In this research the descriptive knowledge of BI systems consisted of the researcher’s observations, classification and cataloguing of contextualised contents from the SA higher education sector. The prescriptive knowledge consisted of derived BI concepts, algorithms, techniques, systems, processes and products particularly from literature.

Document Number	Title	Reference
1	Towards a new Higher Education Landscape: Meeting the Equity, Quality and Social Imperatives of South Africa in the 21 ST Century	(CHE, 2000)
2	Government Gazette: Higher Education Act, 1997 (ACT No. 101 of 1997), Funding of Public Higher Education	(Asmal, 2003a)
3	Policy and Procedures for Measurement of Research Output of Public Higher Education Institutions	(Asmal, 2003b), (DHET, 2012)
4	Government Gazette No. 67, 2008 : National Qualifications Framework Act	(Presidency, 2009)
5	Space and Cost Norms for Buildings and Other Land Improvements at Higher Education Institutions	(Skene & Bunting, 2009)
6	CESM: Classification of Educational Subject Matter	(Skene, Bunting, De Beer, et al., 2009)
7	Building and Space Inventory and Classification Manual	(Skene, Bunting, Mokotedi, Steyn, & Stoop, 2009)
8	Department of Higher Education & Training : Strategic Plan 2010 - 2015	(Nzimande & Metcalfe, 2010)
9	Ministerial Statement on Enrolment Planning 2011/12 - 2013/14	(DoE, 2011)
10	National Development Plan: Vision for 2030	(Manuel & Ramaphosa, 2011)
11	Public Funding of Higher Education in South Africa by Means of Formulae	(Steyn & de Villiers, 2011)
12	VitalStats Public Higher Education 2010	(CHE, 2012)
13	South African Education Information Standards: Data Quality Standard for Surveys	(Nzimande, 2012)
14	A Framework for Qualification Standards in Higher Education	(CHE, 2013)
15	White Paper for Post-School Education and Training: Building an Expanded, Effective and Integrated Post-School System	(DHET, 2013)
16	Quality Enhancement Project: The Process for Public Higher Education Institutions	(CHE, 2014)
17	Guidelines for Clinical Training Plans and Budgets: 2014/15 & 2015/16	(DHET, 2014a)
18	Policy Framework on Differentiation in the South African Post-School System	(DHET, 2014c)
19	Ministerial Statement on Enrolment Planning 2014/15 - 2019/20 for Universities	(DHET, 2014b)
20	Government Gazette, National Qualifications Act, 2008 (ACT NO. 67 OF 2008): Higher Education Qualifications Sub-Framework (HEQSF)	(Mosia, 2014)
21	Higher Education Act, 1997 (ACT NO. 101 of 1997) Section 41 read with Section 69: Regulations for Reporting by Public Higher Education Institutions (37726)	(Nzimande, 2014a)
22	Ministerial Statement on University Funding: 2015/16 AND 2016/17	(Nzimande, 2014b)

Table 5.1: Literature for South African Higher Education Legislative Framework

Descriptive knowledge has two primary forms as Gregor & Hevner (2013) argued. The descriptions of the natural, artificial and human related phenomena being composed of observations, classifications, and measurements then cataloguing these descriptions into forms that are accessible. It is apparent from the descriptive knowledge delineated above that there is a need for timely, comprehensive, detailed and good quality statistical data. Such data will be required as an information base that is of ultimate significance in the growth

of plans and strategies, assessment of attainment of objectives and targets, and development of policy advice for the Government and within institutions.

This study had shown that the current BI processes for collecting and accessing such statistical information does not serve that need well within the SAHEIs. Therefore, the researcher shows the DSR methods used to develop the CABIF. The researcher shows how the prescriptive knowledge within the BI domain contributed to the development of the CABIF. As mentioned earlier, the PCA subjected to the BI measures contributed immensely to the development of the CABIF. The process of eliciting the BI descriptive knowledge within the SA higher education assisted in deriving the higher education management information system (HEMIS) data set (Skene & Bunting, 2009; Skene, Bunting, De Beer, et al., 2009; Skene, Bunting, Mokotedi, et al., 2009).

5.7.5 Design Science Research Methods

The first step in DSR is identifying the problem, which the researcher had already done and is embedded in the third research question. The research approach is a mixed methods research approach and has been predominantly sequential in nature. The principal components analysis on the 34 BI importance generated eleven components/factors which were subjectively named in the following eleven diagrammatic representations. The design and development of CABIF also followed a thorough research into BI concepts and technology concepts. The PCA generated the following BI features which were subjectively named based on the theoretical concepts of business intelligence:

- Business Intelligence penetration enablement
- Business context and key institutional performance indicators
- Business Intelligence Frameworks and proven methodologies
- Business Intelligence constraints and assumptions
- Lines of business drivers for business intelligence
- Business processes planning
- A broad set of business intelligence stakeholders
- Efficacy of Business Intelligence Technology performance
- Managerial decisions and actions enablement
- Data Architecture
- Governance principles

The descriptive and the prescriptive knowledge gathered assisted in developing the intended artefact, which is the CABIF for the SAHEIs. In this research, the researcher assumed that the construction of the CABIF and its description in terms of the design principles and technological rules, contributed to the BI domain in SA higher education. This artefact as is described below is the first attempt in theorising BI systems in the South African higher education from a process and context perspective. The researcher started the development process by cataloguing, clustering and combining the BI satisfactory and importance factors with their respective characteristics. The BI characteristics that loaded on the factor with their magnitude of correlations values greater or equal to ± 0.3 , were considered. The clustering for the respondents' BI satisfaction measures was, and the same was done for the BI importance measures.

5.7.5.1 Business Intelligence penetration enablement

The BI Importance Component 1 shown in Figure 5.1, was named "Business Intelligence penetration enablement" after the following observed BI importance variables loaded heavily on it:

- Business Intelligence Analytical Framework
- Access to data and reports via the internet
- Access of data and reports from a single area
- Business Intelligence System Response time
- Business intelligence tools to support decision making processes
- IT and University core business teams working together
- Executive management support
- Understanding the institutional culture and politics that exist and obstacles to look for change

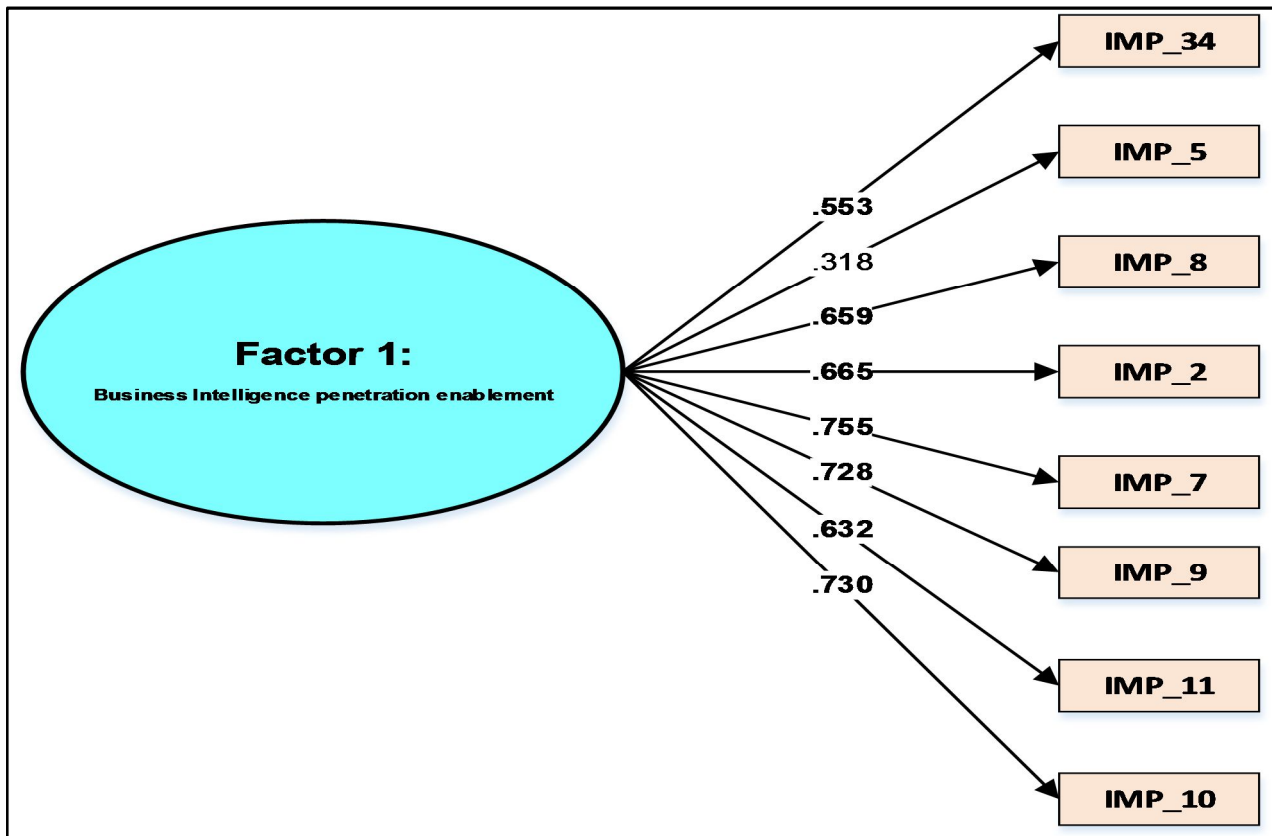


Figure 5.1: Business Intelligence penetration enablement

5.7.5.2 Business Context and Key Institutional Performance Indicators

The second BI Importance Component shown in Figure 5.2, which was subjectively named “Business Context and Key Institutional Indicators” after the following observed BI importance variables loaded heavily on it:

- Data governance alignment
- Organizational design approaches for business intelligence tools
- IT governance alignment
- Creating technology standards
- Business Strategy alignment
- User adoption enablement
- Assessment of current BI/IT and business relationship

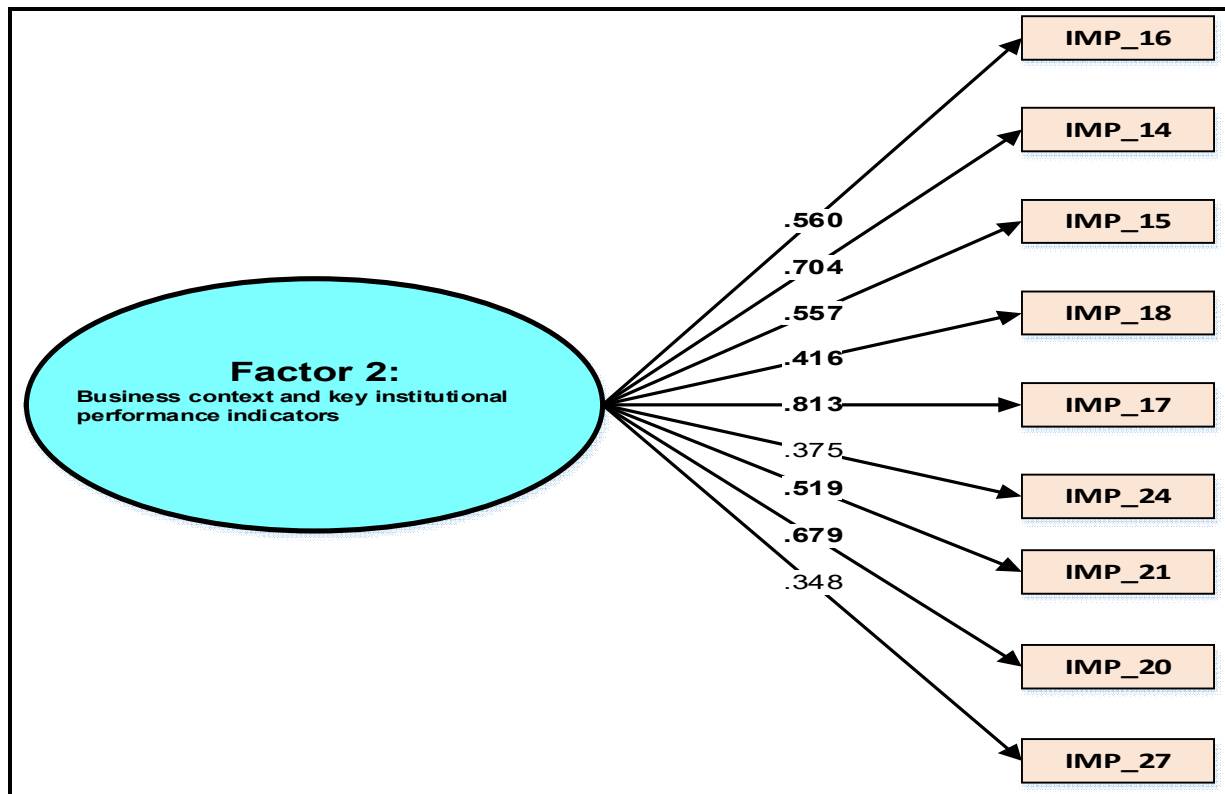


Figure 5.2: Business Context and Key Institutional Performance Indicators

5.7.5.3 Business Intelligence Data Architecture

Figure 5.3, shows the third BI importance factor which was named “Data Architecture” had the following observable importance measures loading with correlations with magnitudes greater or equal to ± 0.3 :

- Business Intelligence Data Architecture
- Enterprise Data Warehouse
- Business Intelligence Users Support
- User adoption enablement
- Business Intelligence data quality
- Training plan for the users

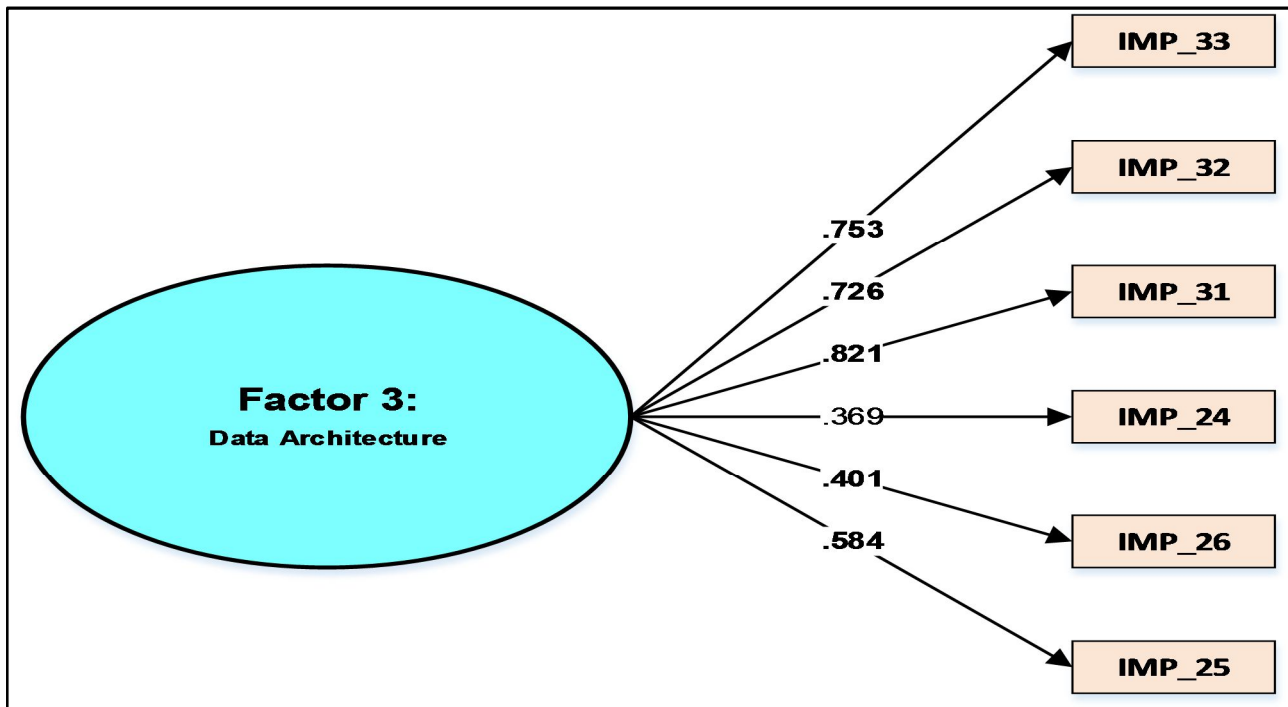


Figure 5.3: Data Architecture

5.7.5.4 Managerial Decisions and Actions Enablement

Business intelligence systems assist managers to make informed decisions. When it comes to higher education institutions, decision making is a habit and a process as well. Effective and successful decisions is the most critical process in any institution. In naming the BI Importance component “Managerial Decisions and Actions Enablement”, the researcher looked at the process of decision making, and the use of BI tools, techniques and perceptions. The researcher attributed the factor name, shown in Figure 5.3, by examining the observed importance measures that loaded on the factor and these were:

- Access to data and reports via the internet
- Top decision areas are addressed and prioritised in the information system
- Quality of Technical support
- Frequency of System Errors
- Assessment of current BI/IT and business relationship
- Communication Plan to various stakeholders for BI/IT implementations
- Training plan for the users

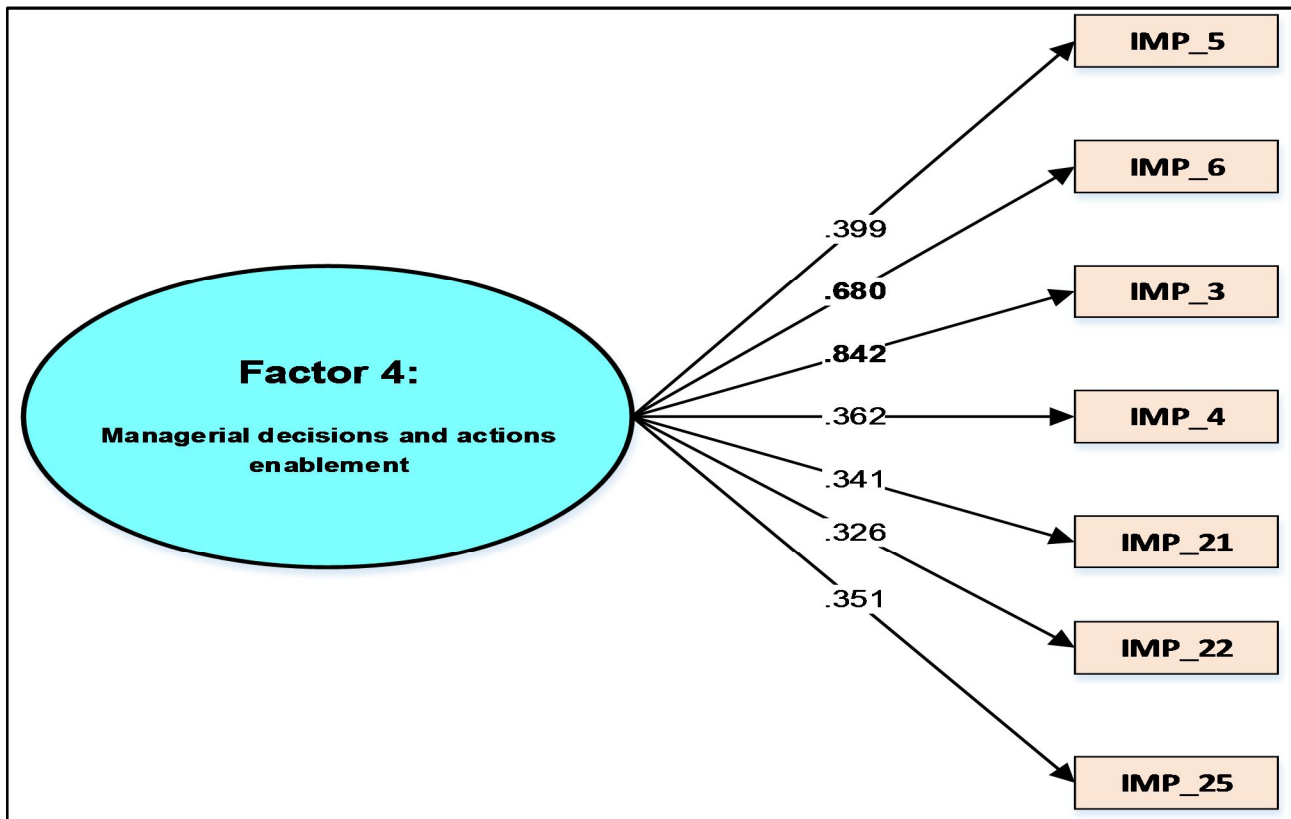


Figure 5.4: Managerial Decisions and Actions Enablement

5.7.5.5 A Broad Set of Business Intelligence Stakeholders

One of the core focuses in this research was to help the BI users in the SA higher education understand and utilize Business Intelligence. This is not normally an easy task, but the researcher is of the opinion that, if the BI system is understood institution-wide then managers would make informed, effective and efficient decisions. The level of BI success in any institution depends primarily on how the BI users are using the gathered information. In attributing the fifth BI importance factor the name, “**A Broad Set of Business Intelligence Stakeholders**”, the researcher thought that aligning people, business processes and technologies to achieve institutional intelligence has significant advantages. Figure 5.5, shows, the following BI observed importance factors loaded with high correlations on factor 5:

- Business Intelligence System Response time
- Organizational design approaches for business intelligence tools
- Business intelligence competency and skills
- User adoption enablement
- Assessment of current BI/IT and business relationship

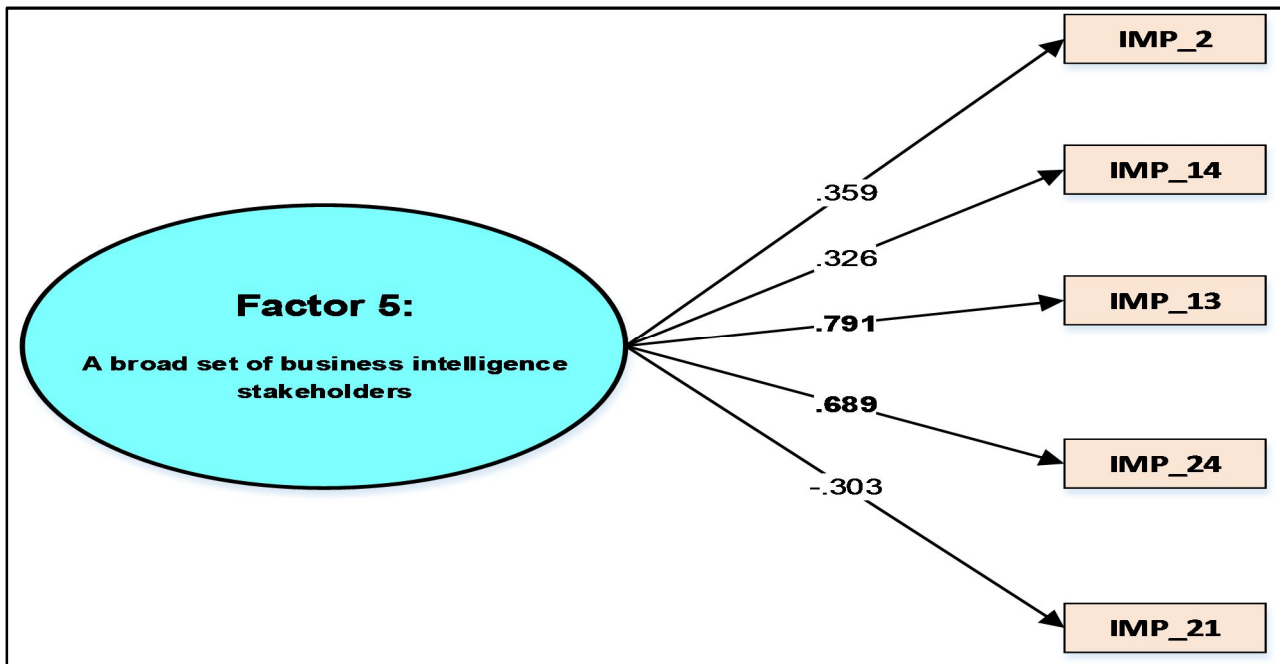


Figure 5.5: A Broad Set of Business Intelligence Stakeholders

4.7.5.6 Efficacy of Business Intelligence Technology Performance

The researcher named the sixth BI importance factor, shown in Figure 5.6, “**Efficacy of Business Intelligence Technology Performance**”. It is the researcher’s view that a BI system is efficient if it utilizes the people and technology resources optimally.

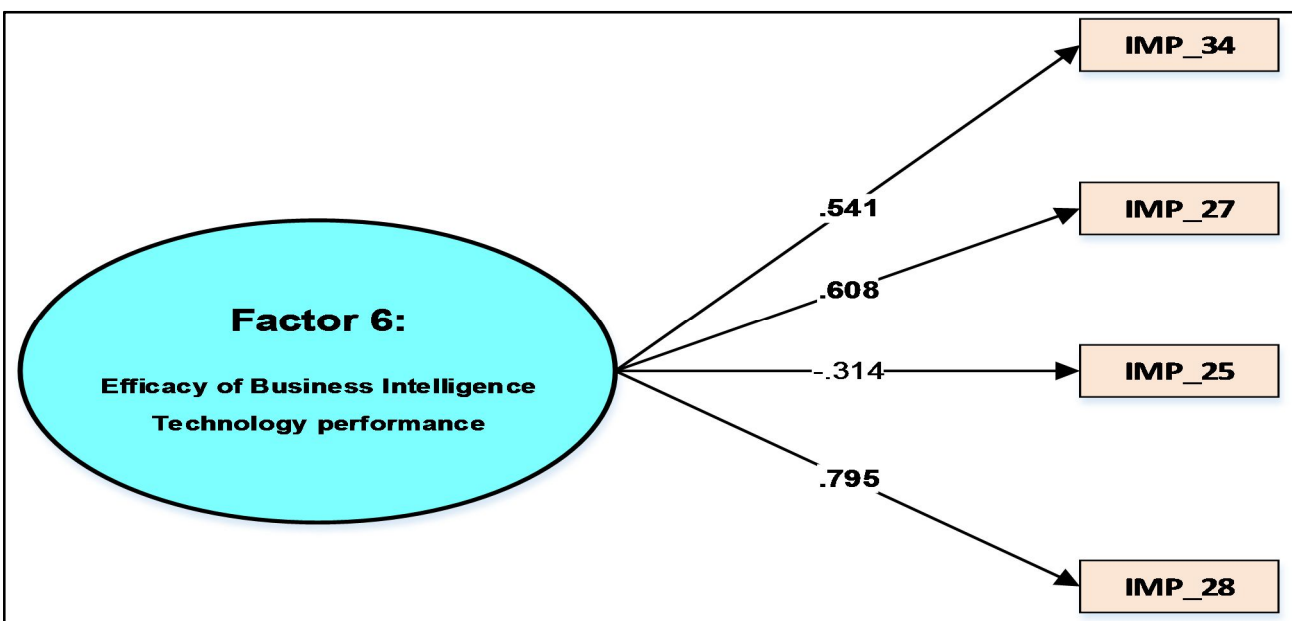


Figure 5.6: Efficacy of Business Intelligence Technology Performance

The BI system at any institution in SA, needs to deliver a consistent service to its users. In order to achieve this mandate, the institution is required to recognize, comprehend, and

produce BI goods, services, and answers that focus on the users' business requirements. The observed BI importance measures which loaded on the sixth component are:

- Business Intelligence Analytical Framework
- Business intelligence standards
- Training plan for the users
- Support of a broad range of users

5.7.5.7 Business Process Planning

This research has made the researcher to believe that institutions of higher education in South Africa have to identify the perpetual requirement for their core business transformation and adaptation. In attributing the seventh BI importance factor the name, “**Business Process Planning**”, the researcher viewed the observed BI importance variables that loaded on this factor, as if they require institutions to review their business models in order to improve upon their value propositions.

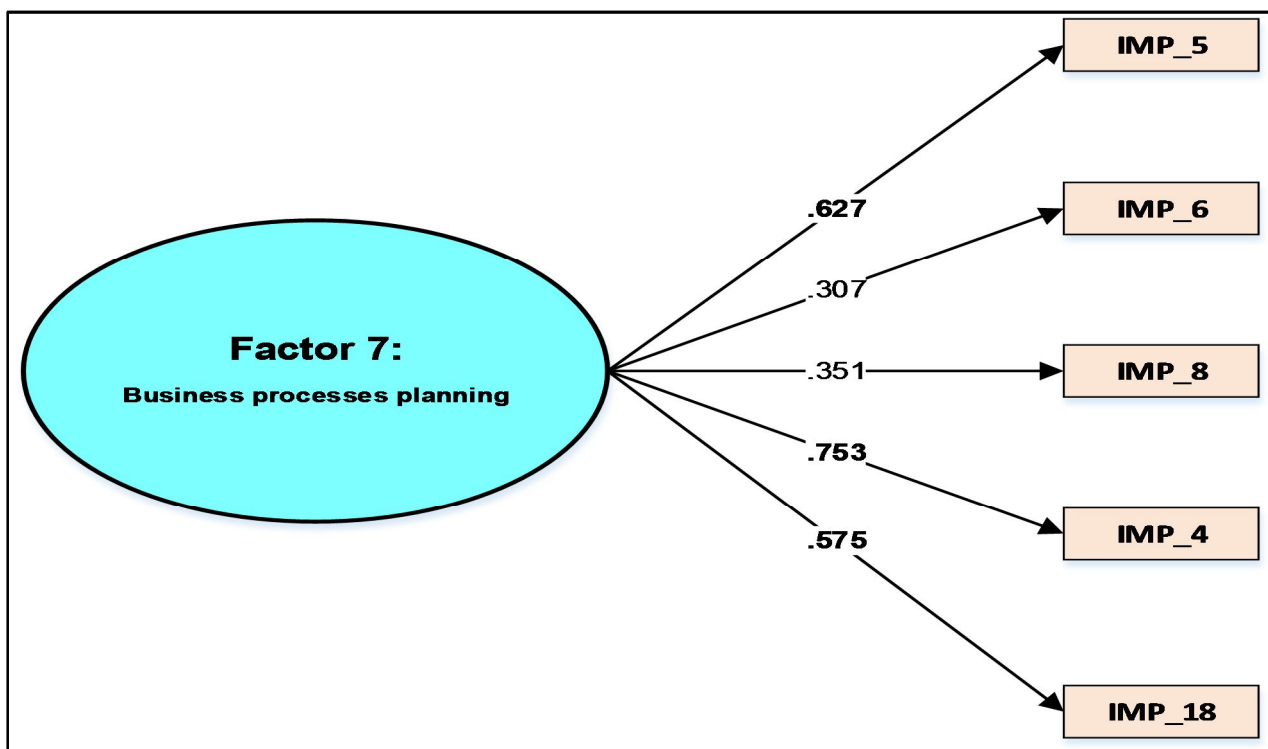


Figure 5.7: Business Process Planning

The observed BI importance measures shown in Figure 5.7 loaded on the seventh importance factor are:

- Access to data and reports via the internet
- Top decision areas are addressed and prioritised in the information system
- Access of data and reports from a single area

- Frequency of System Errors
- Creating technology standards

5.7.5.8 Lines of Business Drivers for Business Intelligence

Figure 5.8 shows the eighth BI importance factor which was attributed the name, “Lines of Business Drivers for Business Intelligence”, because BI should acquire rapid responses to acute core institutional business questions. The BI solution should be structured in such a way that it gives important reports and information to key institutional lines of business.

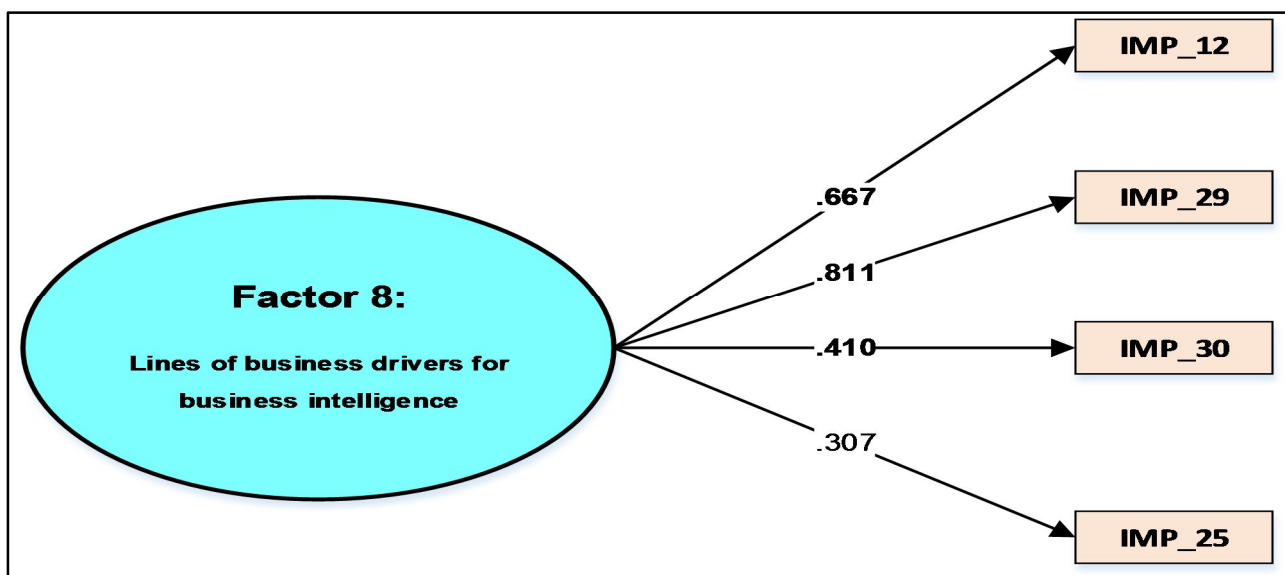


Figure 5.8: Lines of Business Drivers for Business Intelligence

The factors that loaded on the eighth BI importance component include:

- User adoption of the business intelligence technology
- Business Intelligence Standards and Frameworks
- Business Intelligence data quality
- Training plan for the users

5.7.5.9 Business Intelligence Constraints and Assumptions

The research acknowledges that a BI project is just like any other IT project, it is subject to risks that are inherently unavoidable. Risks affect the project deliverables including its schedule. While the researcher acknowledges that the lines of business and IT want quality, rarely is quality achieved without looking at the constraints. This research also acknowledges that certain assumptions are made when designing and implementing an institution-wide BI solution. In this study an assumption is whatever is taken for granted

during the BI project roadmap. If the assumptions are not documented properly these would turn into BI project risks.

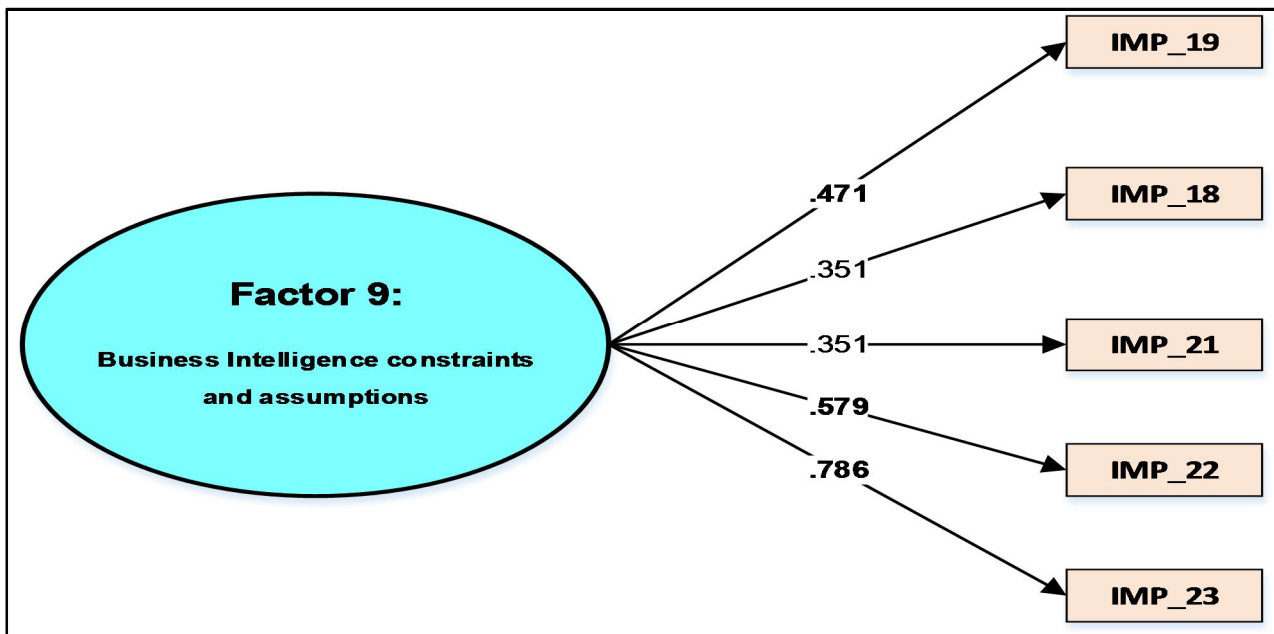


Figure 5.9: Business Intelligence Constraints and Assumptions

When the researcher looked at the following BI observable importance variables that loaded on BI Importance Factor 9, the factor was subjectively named, “Business Intelligence Constraints and Assumptions”, as shown in Figure 5.9. The factors which loaded on the BI Importance Factor 9, with correlations values of magnitude ± 0.3 were:

- Provision of ICT accessibility
- Creating technology standards
- Assessment of current BI/IT and business relationship
- Communication Plan to various stakeholders for BI/IT implementations
- Organizational Plan to establish a business case for BI investment

5.7.5. 10 Business Intelligence Frameworks and Proven Methodologies

The tenth BI Importance factor was attributed the name “Business Intelligence Frameworks and Proven Methodologies”. The concept of BI framework is a key concept in the research. The researcher took note that a BI framework assist in defining the human resources, core business processes and technology platforms that need to be integrated and aligned to take a more strategic approach to institutional BI projects. The BI framework and standard conventional methodologies are used by software engineers or BI system developers to integrate all the components needed for a successful BI initiative.

The importance BI observable variables shown in Figure 5.10, which loaded on the tenth BI Importance Factor, prompted the researcher to think of the need for institution-wide core business metrics to be included in the BI framework. The BI framework should in this case thrive to enlance the institutional strategic objectives with their respective operational activities. The researcher viewed a BI framework as a mechanism of reducing the siloed approaches to the implementation of BI initiatives within the institutions.

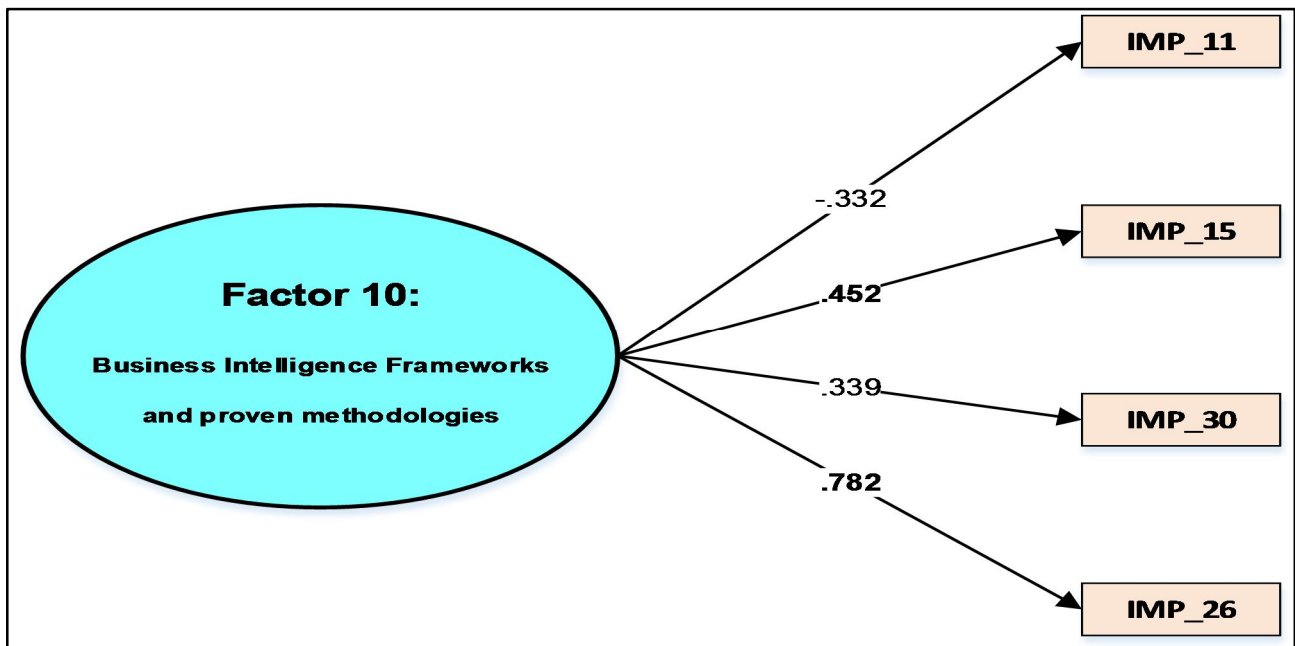


Figure 5.10: Business Intelligence Frameworks and Proven Methodologies

The metrics that maybe included in the BI framework might include looking at the cause and effect relationships between leading and lagging of the following BI characteristics:

- Executive management support
- IT governance alignment
- Business Intelligence data quality
- Methodological processes for BI implementations

5.7.5.11 Business Context and Key Institutional Performance Indicators

In South African higher education in most cases the different parts of the institutions create performance management strategies and initiatives at the intermediate levels of the institutional hierarchy. These performance plans are usually integrated to the institutional strategic plan as is required by the DHET. The failure by individual institutional entities to connect their performance plans and performance management initiatives to the institutional performance plans, may result in suboptimal institutional strategic performance. In naming

the eleventh and final BI Importance factor, “Business Context and Key Institutional Performance Indicators”, the researcher took into account the role BI has in critical success factors for the institution. The observed BI importance variables, being shown in Figure 5.11, that loaded on this eleventh factor included:

- Technology and Business alignment
- Access of data and reports from a single area
- User adoption of the business intelligence technology
- Data governance alignment
- Provision of ICT accessibility

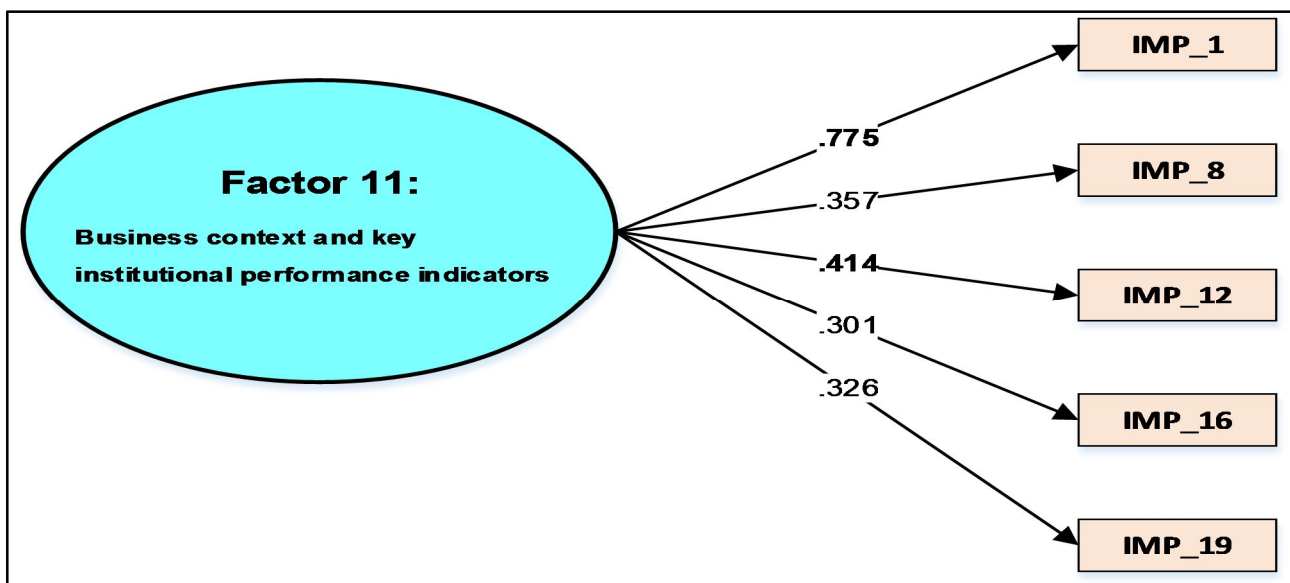


Figure 5.11: Business Context and Key Institutional Performance Indicators

5.7.6 Integrating BI Knowledge Using Design Science Research

Design science research allowed the researcher to use the prescriptive knowledge and knowledge of BI systems within the higher education sector. The PCA analysis subjected to both BI satisfactory and importance measure allowed to reduce the 34 BI variables to 15 variables. These came from the four BI satisfactory factors and the eleven BI Importance factors generated. This study indicated that there is a fragmentation of conventional and standardised BI frameworks and approaches used by the SAHEIs. There is therefore, a need for the SA higher education institutions to move from a tactical to a strategic approach to BI implementation approach. By taking BI, analytics and institutional performance management as a strategic intent the need for a standard framework will arise within the SA higher education sector.

After seeing that the 34 variables can be clustered into different factors, DSR was deployed to move towards a strategic approach to the development of a context-aware BI framework. It is important to acknowledge that, when BI is being approached tactically within an institution, the individual institutional business process is treated in isolation. This research shows that approaching institutional BI initiatives strategically, the diversity of analytic processes within the institution is understood holistically, as multiple lines of business are taken into account. The strategic view to the implementation of BI within the institution, will therefore, encompass core institutional business processes, decision processes, an information infrastructure with the analytics and performance management integrated into the BI framework. Using DSR processes of cataloguing and clustering of BI characteristics that had a magnitude of correlation value greater or equal to ± 0.3 , the following Figure 5.12 shows the researcher's first attempt to develop the CABIF.

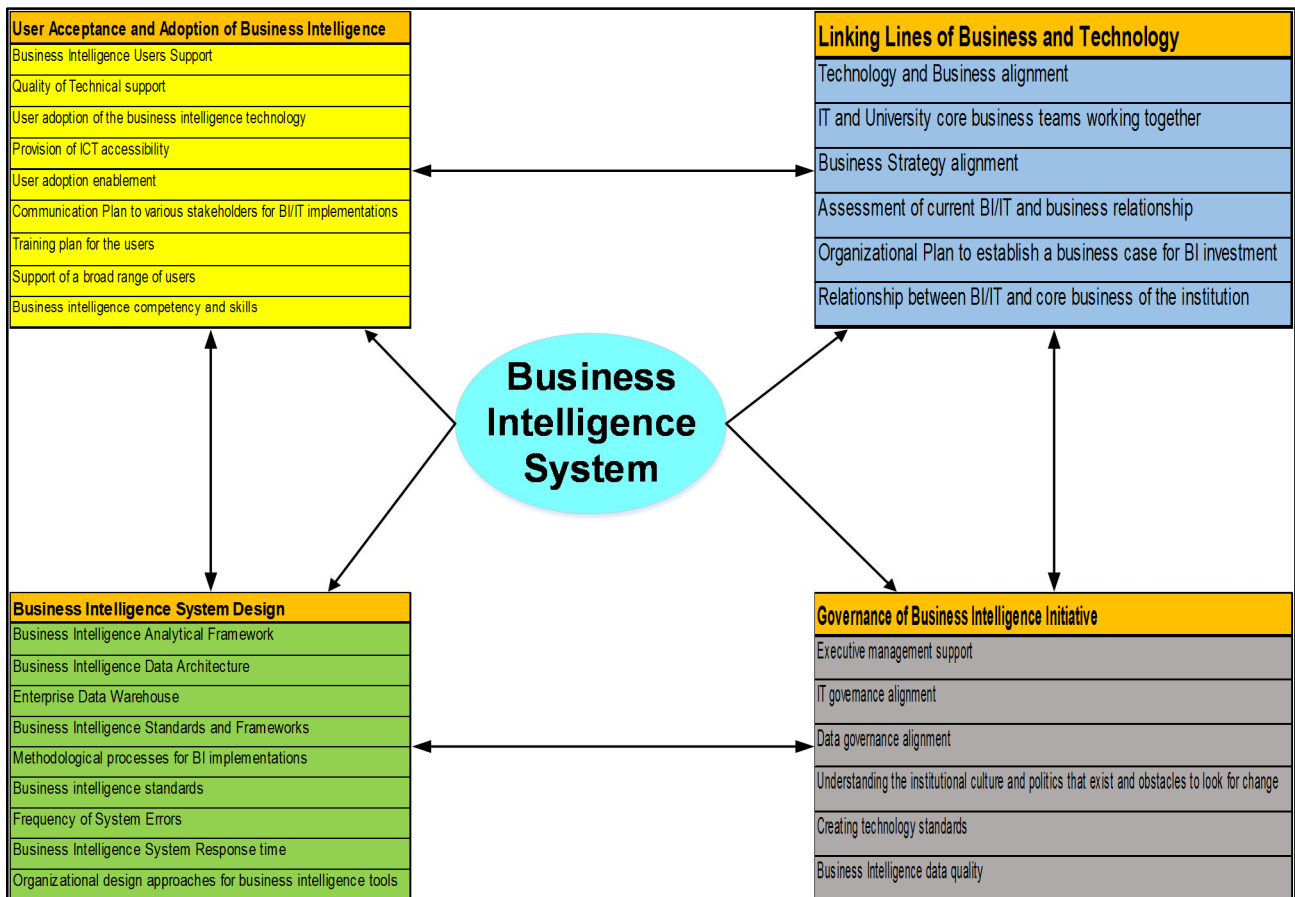


Figure 5.12: Clustering the BI characteristics after Principal Components Analysis

Clustering the BI characteristics after PCA and subsequently applying DSR produced only four BI clusters from the SA higher education sector. The four clusters are Business Intelligence Systems Design; User Acceptance and Adoption of Business Intelligence; Linking Lines of Business and Technology; and last but not the least Governance of

Business Intelligence Initiative. The double arrows on each four nodes symbolises that there is a symbiotic relationship between the four clusters. A BI system relies on all the four BI clustered nodes to be successful. These four BI clusters can be seen that these are generic and does not reflect the context of South African higher education. Using DSR again, the researcher took a step further to refine these four BI clusters into SA higher education contexts. The following section illustrate the refinement process of the clusters in a BI framework for SAHEIs.

5.7.7 Description of the Context-aware Business Intelligence Framework

This research shows that the CABIF in the SAHEIs requires BI practitioners to know and understand various institutional core business contexts. They should not only know these business processes, but they should be aware and interested in that these business processes exist. The BI systems should be able to garner access to data from both internal and external information systems. The yielding of core business values through the data from BI systems is paramount in providing individual institutional performance success. This researcher argues that, SAHEIs have to be transformed from being institutions rich in data assets, to institutions generating knowledge from these data assets. The institutions should harness BI systems by generating real-time knowledge that drive the universities' core business. Using DSR compounded by the PCA on BI importance measures, the researcher identified five principal BI contexts in the CABIF, and these are: Basic Context: Premise; Process Context which consisted of Macro activities and Micro activities; Business Intelligence Context; Business Intelligence Skills Context and last Governance Context.

5.7.7.1 The Basic Context: the Premise

The researcher established that there are basic contexts that a BI framework within the SA higher education sector needs to fulfil. This is referred to as the basic context, or the premise, these are the necessary conditions, where everything starts. The basic business intelligence context in this research refers to those BI features, or university core business drivers that are most necessary and from which other BI contexts evolve. BI practitioners in the SAHEIs should be aware or sensitive to the Basic Context. This context forms the basis for the BI framework, and the springboard for subsequent BI contexts within the framework. As an example, the **academic programme/qualification** can be referred to as a basic context within CABIF.

The academic programme/qualification at any SA higher education institution fulfils almost all the pathways found in the legislative framework, mentioned in the descriptive knowledge phase of DSR. The academic programme complies with all its statutory requirements as follows:

- Fulfils one of the National Qualifications Framework (NQF) levels
- Needs institutional approval usually through the Senate Committee
- It is put on the DHET approved Programme Qualification Mix
- Accredited by the Council on Higher Education
- Registered by the South African Qualifications Authority
- Registered and accredited by the Professional Body if needed

When all the legislative/statutory framework is met, the qualification is then administered within the institution. In order to be administered in the institution, the qualification would need at least the following:

- Enrolled students
- Academic staff to teach the courses/modules within the qualification
- Administrative/support personal to handle administrative tasks
- Learning spaces such as lecture halls, laboratories classes etc.
- Funds to sustain the operational requirements of delivering the qualification

The establishment of a qualification at any institution triggers the birth of various data assets within the institution. In the South African higher education data assets for HEMIS, finance, facilities, assets etc. are generated. These data assets need to be accurate and reliable therefore, the Basic Context for the generated CABIF, is complimented by data quality processes. The development and implementation of the academic/programme at any institution triggers what the researcher referred to as the *Business processes planning* and *Lines of business drivers for business intelligence* through the PCA of BI importance dimensions. During the establishment of a qualification within any institution most of the data are housed within the operational systems. This researcher argues that, most operational systems within the higher education sector are not intended for information retrieval and investigative/analytical processing. The core business drivers for each institution, and their planning requires a substantial amount of information retrieval and analysis. Business intelligence systems are designed for such a purpose. In the development of the CABIF, the researcher thought that the understanding of the SA higher education core business drivers, and its diverse business processes, will make the CABIF a success. Therefore, the

researcher suggests that any BI practitioner within SA higher education should understand these various core institutional business contexts. The researcher inherently named this the Process context within the CABIF.

5.7.7.2 The Process Context

Research had shown that an institution with a BI and analytics stratagem empowers its employees, by giving them the credible information timeously and allows them to make noble decisions (Sherman, 2015). The BI and analytics approach should not only address the information needs of the whole institution, it should also align IT and the lines of business. The process context of CABIF was divided into two components, which were named the 'Macro-Process context' and the 'Micro-Process context'. Within the South African higher education, the macro-level process context is referred to, as those business processes that are large and are capable of generating complex large data sets. The researcher suggests that, these lines of business processes within SA higher education require to be broken down to lower levels of granularity for a BI program to be successful.

5.7.7.2.1 Macro-Process context

The following are examples of macro-level process contexts that come from some of the practices in the South African higher education:

- Academic planning
- Student enrolment management
- Human resources planning and management
- Financial resources planning and management
- Facilities and Estates planning and management
- Teaching and Learning
- Community engagement
- Research Management
- Data profiling

The macro-activities that define the institutional business processes are in most cases linked to and regulated by a legislative entity. This is a mere demonstration that the CABIF has interrelated contexts and these shape the diverse features of the BI framework within the sector.

5.7.7.2.2 Micro-Process context

As has been mentioned the macro-level contexts need further disintegration into lower levels of granularity. This lower level of the Process Context of CABIF is the micro-process context. In this research the micro-process context of the CABIF refers to small scale business processes which are sub processes of the macro-process context. This entails that each macro-process context can contain a number micro-process contexts. The following Table 5.2 shows examples of the relationship between macro-process contexts and micro-process contexts within South African higher education:

Macro-Process Context	Micro-Process Contexts
Academic Planning	• Programme Approval Cycle (PQM) • Academic Planning Structures • Academic Business Plans
Enrolment Management	• Student tracking • Cohort Analysis • Enrolment Planning and monitoring
Human Resources Planning	• Staff Allocation • Performance Management
Financial Resources Planning	• Academic Financial Viability • Administrative Financial Viability • Budget Allocation • Financial Allocation Models • Tuition fees
Teaching and Learning	• Course persistence • Qualification persistence
Facilities and Estate Planning	• Space Category Planning • Assigned Square Metres Planning
Data Quality Processes	• Data Profiling • Data Auditing
Institutional Strategic Planning	• Annual performance Plans ○ Key Performance Areas ○ Key Performance Indicators

Table 5.2: Macro-process and Micro-process contexts in SA higher education

In drawing up these BI contexts, the researcher is of the opinion that a solid contextualised BI framework is crucial in wrenching collectively the business contexts across any higher education institution. In this research, an understanding of the institutional business processes is key to a successful CABIF. In this research, the researcher found out that the major obstacles to the construction of a successful BI initiative include lack of alignment between IT and the core business processes (Parenteau et al., 2014; Sherman, 2015;

TDWI, 2015) . The tendency to jump to technology decisions or architecture without considering what business problems the institutions is confronting is detrimental to a successful BI framework (Briggs, 2014; Fish, 2014; Gartner, 2014). BI is no longer an initiative just for IT, as it has evolved into different shapes and sizes based on business needs, expectations, and budgets. An effective BI approach benefit both the IT and lines of business (LOB) within the HEIs. The PCA subjected to the 34 BI observed importance measures generated the following factors:

- Business context and key institutional performance indicators
- Business Intelligence Frameworks and proven methodologies
- Business Intelligence constraints and assumptions
- Efficacy of Business Intelligence Technology performance
- Data Architecture
- Governance principles

The factors above prompted the researcher to generate another context for the CABIF which was named the 'Business Intelligence Context'. The Business Intelligence context of the CABIF includes aligning institutional business entities, ratifying and sanctifying business needs, delivering an all-inclusive strategic BI solution, which identifies a shared set of goals and delivers planned results within the institution. The researcher concluded that, if the CABIF is able to tie core institutional business activities to actionable analytics initiatives, this would contribute to better institutional performance.

5.7.7.3 The Business Intelligence context

The Business Intelligence Context of the CABIF consists of an array of elements that encompass and shape the whole BI strategy at the SA higher education institutions. This context of the CABIF covers the functionality of the BI system, the technology infrastructure, and selecting the right technological choices for the system. The context allows for the institution to assess the business drivers from the institutional core business areas to be addressed. This context defines the BI metrics within the framework such as data management, information delivery, data analysis framework (data mining and including analytics), the data architecture which might include data marts and data warehousing. The Business Intelligence Context of CABIF also critically show how the BI system can perform the functionality for specific vertical or horizontal business specializations within the institution. This Context suggest that the BI tools used within the technology solution, should also fit within the existing institutional IT infrastructure.

Some architectural ingredients of the BI solution should include a solution that is robust, scalable, extendable and highly secure. Data integration, and consistency is also an important aspect of the Business Intelligence Context of the CABIF. The BI Context of CABIF also suggests that the BI system selected at the SA HEI, should allow for a heterogeneous data access within the institution. In many of the SA higher education institutions multiple data sources of numerous dissimilar types exist. The BI system should be able to integrate these several heterogeneous data sources, including structured and non-structured data for analytics. The researcher concluded that, the BI context of CABIF should advocate for the globalization of the BI initiatives within the institutions. The global capability defined with the BI standard entails that the BI systems within the institutions must be deployable in the language of the users' preference.

The BI context of CABIF also emphasise that the BI solution within the institution should adhere to existing technology standards with the institution including the information security policy. This means that BI practitioners within the higher education sector in SA does not have to duplicate or change the approach already implemented for technology standards including ICT governance within their institutions. The BI standard should be deployable in multiple portal technologies that might be used within the institution. The researcher concurs with Weir (2012) who argued that generating standards around software tools decreases costs and boosts return of investments. As the institutions grow, they accrue stratum of data assets. We agree with Sherman (2015) who argued that organizations accumulate data in ever-increasing volumes, whilst the variety and velocity of data is also increasing. The CABIF suggests that combining those sources into depositories that comprise of shared datasets, e.g., data warehouses, is the common step toward developing a single version of the institution's state.

This research has shown that within the SA higher education sector data warehouses themselves are often disjointed amongst data silos based upon division-level or departmental requirements. These data silos often result into Spreadmarts as BI Gurus refer to them. Institutions are faced with challenges of organizing and understanding their data assets. It is essential to note that, data assets do not add any value to the institutions, unless they are understood, analysed and users act on the insights based on the data analysis. HEIs in South Africa are adept at collecting all kinds of data about their students, staff, internal core business processes such as research, finance, suppliers and facilities/estates.

The capturing of these sets of data is just one step, but usually institutions face the deluge of information which they cannot analyse effectively. In this research, the researcher contends that leveraging the variety, volume and velocity of data with analytics is paramount to BI success within the SAHEIs. The data analytics framework is therefore an important ingredient of the BI context of the CABIF. Managers in HEIs depend on the data to validate their intuitions during their decision-making processes. This researcher also claims that, certain competencies or skills are required to achieve all the elements that have been mentioned in the various contexts of CABIF. The researcher then developed the 'Business Intelligence Skills Context' of the CABIF to fulfil this gap.

5.7.7.4 The Business Intelligence Skills Context

This researcher makes a case that, the success of any BI initiative relies on people equipped with a number of competencies. The results of the PCA on the observed BI importance measures resulted in that the BI competency and skills measure loaded with a high correlation value of 0.791 on the principal component/factor number 5. This result on its own is a testimony on how the respondents of the BI survey valued the importance of BI skills within the sector. This researcher also contends that, BI within the SAHEIs has to go beyond data analysis and the usage of information in the decision-making processes. The information from the BI system should be used for the broader institutional strategies, and support key business processes. In order to achieve this, the Business Intelligence Skills Context of CABIF suggests that institutions need an amalgamation of business skills, IT skills and analytic skills. The researcher refers to these set of skills as '*the triad of BI skills*' for the CABIF as shown in Figure 5.13.

The CABIF suggests that the leveraging of IT skills, business skills and data analysis skills is key to the success of any BI initiative within the SA higher education. The analytical skills include being able to forestall business issues and produce analytical models to deal with them. People with analytical skills can determine correlations, regressions, trends, patterns etc. on available data. They are also capable to discern the data that needs further analysis and are capable of applying various statistical analysis, data mining and data aggregation. Another important but often underestimated set of skills, is that people with analytic skills should be able to present data in some manner users understand. The people with business skills should, have the knowledge and understanding of the various institutional business units. These people should also have adequate know-how to align

strategic BI goals with institutional goals and express them undoubtedly to the executive management. People with business skills work collaboratively with LOB managers on return of investment models on BI, BI business cases and the prioritization of activities.

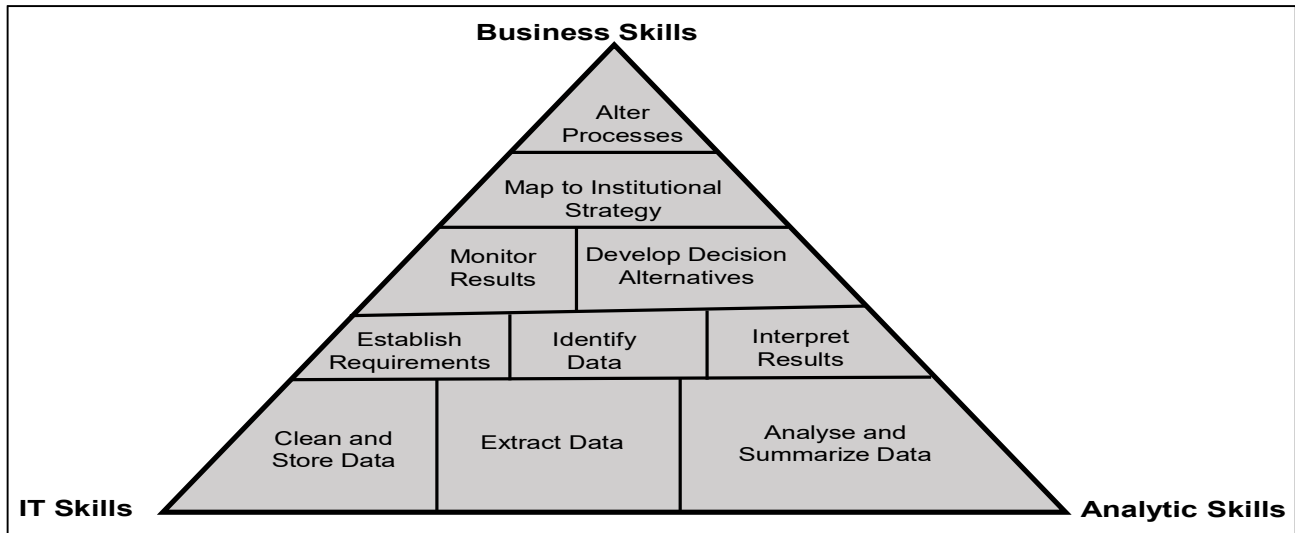


Figure 5.13: Business Intelligence Skills Set

People with IT skills in the BI environment on the other hand significantly understand how institutional business processes and analytical skills are impacted by the IT infrastructure. The IT people should be able to bring forth ways to support institutional core business and data analysis requirements, by providing means of accessing and managing institutional data assets. They also in in the selection of BI technologies and tools, the data warehouse and in data management and administration. The researcher understands that leveraging and converging the triad of BI skills is a challenge on its own. These is because in most cases people with business skills, especially who understand change management processes resides in other institutional business units. In the quest to tie together these three set of skills, other researchers have suggested the creation of the Business Intelligence Competence Centres (Briggs, 2014; Gartner, 2014; Sherman, 2015). The Business Intelligence Competency Centres (BICC) or Business Intelligence Centres of Excellence (BICOE), have been prevalent in other business sectors but these are defragmented in higher education.

The BI personas in the commercial sector have been identified as casual users, analysts, power users and data scientists (Sherman, 2015). Casual consumers of analytics use reports and dashboards to obtain the information they need to fulfil their job requirements. The casual BI users do not delve into the BI applications as they need all their BI reporting

tools filled with data. Most people in SA higher education who range from operational to executives are casual BI users. The people who regularly use the BI applications to gather and explore the data they to fulfil their jobs are the analysts (Sherman, 2015). The data analysis is usually part of their job descriptions, and their job title is usually associated with the word “analyst”. The analysts usually leverage their business knowledge to explore and analyse data using the BI applications and/or spreadsheets. The power users on the hand possess business and technology skills. According to Sherman (2015), these kinds BI users are departmental experts in the BI tools within their institutions. They build and enhance the features of the institutional BI applications hence playing a pseudo IT function. Data scientists are the data and statistical geeks as Sherman referred to them. These are institutional people who have the capabilities to even work with predictive analytics.

Predictive analytics revolutionize BI from merely analysing the past and present data sets to leveraging collective information from these data sets to predict outcomes. It is however, important to note that for a successful BI initiative within the HEIs IT skills need to be harnessed. The BI system should be incorporated into the institutional enterprise ICT architecture. It has been intentional in this research to create a Technology Standards BI dimension which measured the respondents’ satisfaction and importance. The adoption and usage of the BI system depends largely on the politics and culture of the organization. The organizational politics and behaviour are fundamental to BI success as these distinguish the institutional management principles, ICT governance, sponsorship of technology initiatives and user adoption. Based on the results of the PCA on the respondents’ importance and satisfaction with BI measures, included in the BI survey, this researcher came up with the ‘Governance Context’ of the CABIF.

5.7.7.5 The Governance Context

This researcher confesses the fact that specifying the various components required for implementing BI systems in institutions of varying sizes and shape is a task fraught with complexities. The researcher also acknowledges that each of the SAHEIs is unique, and each has undergone distinct IT and business processes evolutions. The researcher also recognizes that each HEI has incorporated varied BI solutions over time and learned to some extent diverse lessons in the process. This researcher argues that, the fundamentals for BI governance are the adoption, consolidation and creation of technology standards. Institutions have to create standards in their BI, Performance Management, and information

management. They are supposed to consolidate various technology projects to achieve higher levels of efficiency and to reduce costs. This researcher is of the view that, the consolidation of BI initiatives will allow institutions to cultivate a more interconnected view of the data, and to acquire a mutual source of information and gain control in the BI solutions. The Governance of Context of CABIF, allows for BI practitioners to institute BI project management principles, leverage existing IT standards, and most importantly to institutionalize data governance.

5.7.7.5.1 The Technology Deception

Business Intelligence developers may fall into the trap of putting more of their energies on the BI technology products, and the architecture of the BI infrastructure. Technology is something controllable and often BI developers feel comfortable with it. This researcher contends that, the critical success factors of a BI solution lies on the **P³**, which are the **people**, **policies**, and **politics**. These elements are governance elements that are very difficult to predict and control than the technology products. As mentioned earlier, the success of any BI initiative in the HEIs, depends on how it adds value to the inherent institutional business processes. If the institutional departments get the right information to execute their responsibilities then, the BI solution is fulfilling its mandate. Whether the institution has the best BI product in the world, or has a huge data warehouse, people have to get what they want, lest they start to build BI shadow systems to get the information they need.

5.7.7.5.2 Governance Principles

“In recognition of the importance of the Governance of ICT, a number of internationally recognized frameworks and standards, such as King III Code, ISO/IEC 38500 and COBIT, have been developed to provide context for the institutionalisation of the Corporate Governance of ICT”, (DPSA, 2014, p. 9). The King III Code is the acknowledged corporate governance framework in South Africa and is also valid for the State institutions (DPSA, 2014; Nzimande, 2014a). King III Code has been used to apprise the corporate governance of ICT values and practices and to institute the relationship between corporate governance and governance of ICT. The ISO/IEC 385007, is an internationally recognized standard for corporate governance of ICT and it offers governance codes and a model. COBIT is also an internationally recognized conventional process framework for implementing governance of

ICT. “COBIT fully supports the principles of the King III Code and the ISO/IEC 38500 standard in the Corporate Governance of ICT”, (DPSA, 2014, p. 9)

The HEIs as government institutions have to abide by the ICT governance standards, gazetted by the Department of Public Service and Administration (DPSA). The institutional governance of ICT encompasses assessing and guiding the attainment of strategic goals and by means of ICT. BI governance which is embedded in the institutional ICT governance, permit the accomplishment of institutional core business processes by provisioning the opportunity of data governance. The success of the BI project within the institution depends on the collaborative partnerships between IT, core business people, and the executive management. The joint BI application design, development, deployment and ongoing support will make the BI project a success. One key governance aspect provisioned by BI is the ‘*Data Governance*’ opportunity.

5.7.7.5.3 Data Governance

Orr (2011), defines data governance as, “*the discipline of administering data and information assets across the organization through a formal oversight of people, processes, technologies, and lines of business that influence data and informational outcomes to drive business performance*”, (p. 25-26). Managing data assets is often an overlooked process within HEIs. It begins with an implementation of an information asset management system. The information asset management practice assist in globally managing and coordinating people, process, technology, and ensure an alignment of business processes within the institution.

The overall outcome of data governance is that it enables institutions to address issues that can optimize performance of core business processes. This is because data governance instils a culture of accountability, ownership, and confidentiality of institutional data assets. Data governance assist in identifying the group of individuals within the institution who understands the complete life cycle of data from start to finish. To understand the flow of data within the data life cycle needs to be properly documented. At institutional level it is crucial to comprehend where and how data is used by the core institutional business.

5.8 Summary of Context-aware Business Intelligence Framework

This researcher has developed the five principal BI contexts that characterise the CABIF for the SA higher education sector. These BI contexts for CABIF are, the Basic Context: the Premise; The Process Context (Macro activities and Micro activities); the Business Intelligence Context; the Business Intelligence Skills Context; and the Governance Context. These contexts are suitable to map any BI initiative within the South African higher education institutions. Mixed methods research, coupled with DSR, have proved to be a useful methodology to develop the CABIF. The conceptualization of CABIF is based on the principle that, any BI initiative within the SA higher education sector should encapsulate the business processes within the sector. The following Figure 5.13 summarises diagrammatically the CABIF.

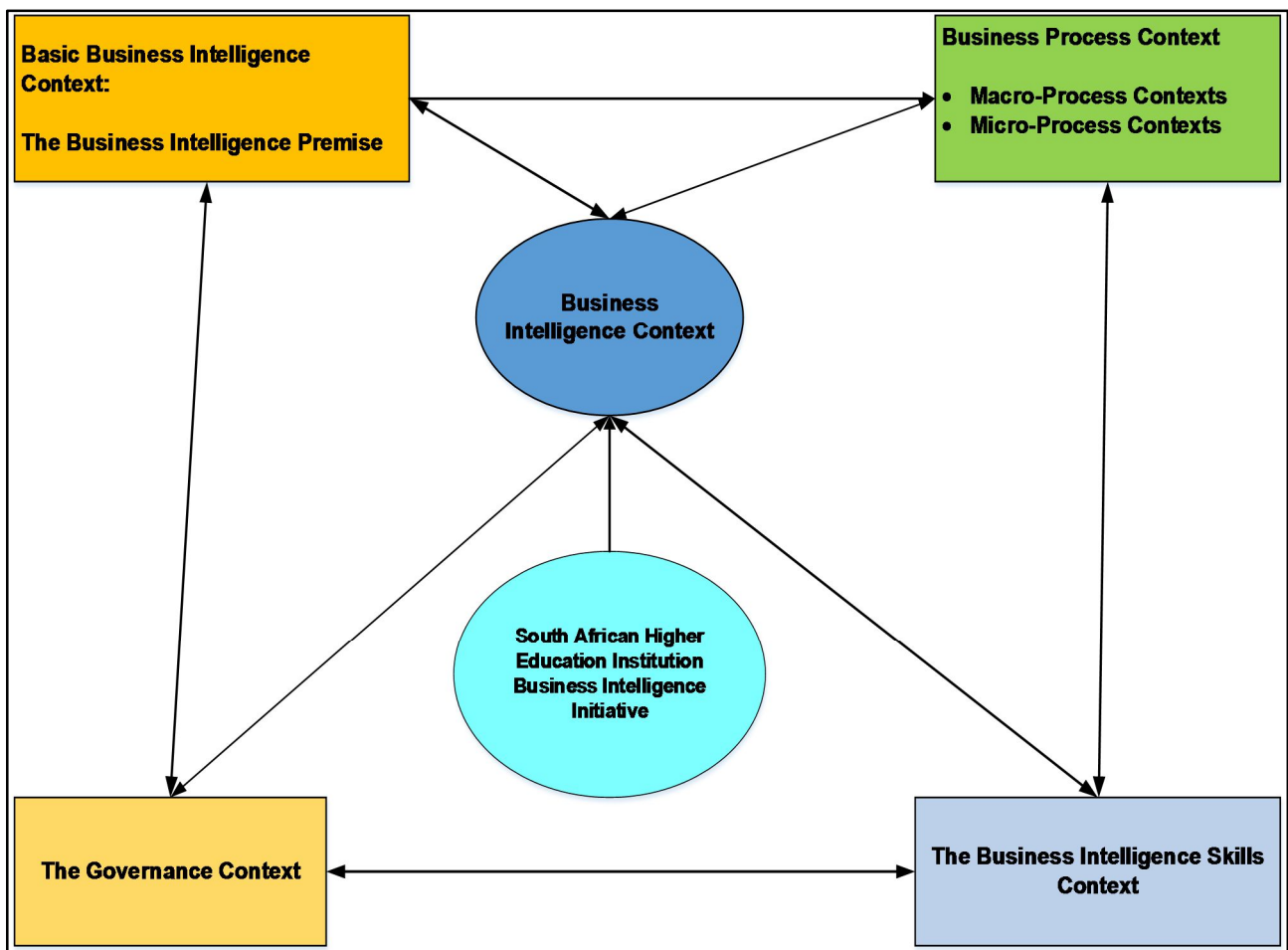


Figure 5.14: Context-aware Business Intelligence Framework

The CABIF starts with the Basic Context, which requires the planning and approval of the academic qualification at the HEI. The legislative framework for the PQM clearance, accreditation and registration of the qualification is fulfilled at this context. The Process

Context immediately follows depicting the macro- process BI contexts and micro-process BI contexts. Both micro and macro process contexts are related to direct business processes within the institution. In order to get value from the BI system, the CABIF has the Business Intelligence Context, which has the data architecture, technology and product architecture, data analysis framework and the design of the BI application.

To achieve all the elements of the BI Contexts of CABIF, there is a need of the triad skills, i.e., IT skills, analytic skills and business skills. The triad of these set of BI skills form the Business Intelligence Skills Context of CABIF. Information assets, ICT, and business processes need to be governed methodologically at each HEI. The Governance context of CABIF is crucial for most of the contexts of the CABIF. The BI design and implementation itself rely on the various governance frameworks, mechanisms and principles in place. This researcher has drawn up a detailed CABIF in Figure 5.15. The detailed CABIF shows a practical decomposition of CABIF in relation to some of the key SA higher education core business areas.

In response to the research questions, *“What Context-aware business intelligence framework is suitable for the South African public higher education sector, and why?”* The researcher can confidently say that the CABIF with the *Basic Context: the Premise; The Process Context: Macro activities and Micro activities; the Business Intelligence Context; the Business Intelligence Skills Context and the Governance Context*, is suitable for the SAHEIs. This is because the CABIF, with these contexts cover core business processes of SAHEIs, and suggests internationally accepted standards for design, development and implementation of BI systems.

The research findings relate to the five research questions and all the sub-research questions that steered this study. The data were analysed to extract, identify, describe and explore the relationships between the variables that could determine factors leading to a suitable context-aware business intelligence framework for the South African higher education sector. The data collected and analysed was not only sufficient to come up with the CABIF, but it was also suitable to determine whether the BI solution implemented using the CABIF at the University of Venda was acceptable and could be adopted within the SA higher education sector.

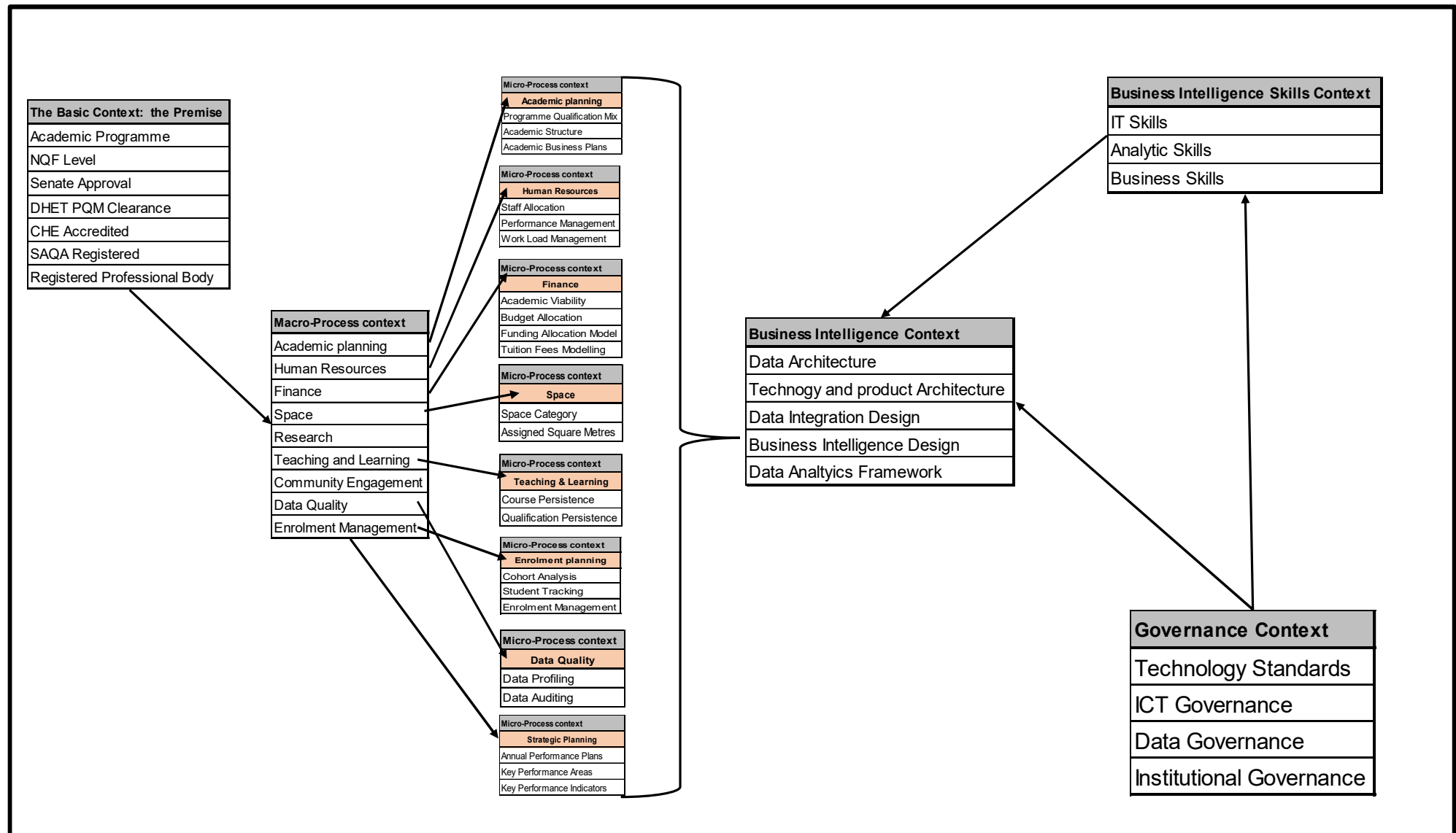


Figure 5.15: Detailed Context-Aware BI Framework for SAHEIs

Chapter 6 : Context-aware Business Intelligence Framework Implementation

In this chapter, the implementation and evaluation of CABIF is demonstrated, as was done at Univen. A number of business processes were identified and mapped on to the CABIF.

6.1 Introduction to CABIF implementation at the University of Venda

The development of the CABIF, was just one of the milestone in this research, as the researcher pursues to validate its conceptualization and practical implementation at one of the SAHEIs, which is Univen. The researcher took a conscious approach by modelling the various BI contexts in the CABIF, and justified why the PowerHEDA reporting framework was chosen as the front-end and the Microsoft Business Intelligence suite as the backend BI technology. The research questions that the researcher was trying to answer were: *“How can CABIF be rolled-out as a vehicle for decision making processes at the Univen? What technology can the Context-Aware business intelligence framework (CABIF) be implemented as a vehicle for decision making processes at the Univen?”* The researcher tried by all means to blend the various institutional resources at Univen, as means of fulfilling the theoretical and practical nuggets engraved in the five contexts of CABIF. The researcher sought by all means to solicit the business cases at Univen, which were mapped based on the CABIF. The research at Univen addressed some of the business process based questions:

- a. *How is the existing technology infrastructure leveraged to accommodate a university-wide business intelligence based management information system?*
- b. *What information presentation formats constitutes reports that facilitate decision making processes within the institution?*
- c. *How do various managers monitor the contribution of their entities through the implemented business intelligence solution?*
- d. *To what extent do users build their own web-based multi-dimensional reports using the developed solution?*
- e. *What indicators allow academic entities to compare their performances in different functional areas?*
- f. *How can the institution measure and monitor performance in key business processes?*
- g. *How useful is the business intelligence application in providing a forecast of the block grants from the Department of Higher Education and Training?*

- h. *What is the end-users' perceived adoption and acceptance of the implemented business intelligence solution?*

6.2 Selection of the Business Intelligence Technology

The selection of the BI technology to implement at Univen has been a tricky question for the researcher. The major headache was to look for a BI product and a vendor that would fulfil all the features embedded in the CABIF. The researcher initially assumed an agnostic position with respect to the BI technology and BI vendor. The researcher resorted to be guided by the BI concepts that have developed in the CABIF, and the results of the empirical research done within the SAHEIs. The BI products were then positioned in a table and arrived at a BI architecture which was thought to be suitable to implement CABIF at Univen. The literature review in Chapter 2, had shown that the history of BI spans some decades ago, and these technologies are evolving every day. BI has become a strategic requirement in most SAHEIs and is continuously growing and being operated in various contexts.

In this research in order to justify the selection of the BI technology the researcher resorted to the responses obtained from survey question, *“What Business Intelligence Systems are you using? (If you do not have the Business Intelligence System please indicate)”*. The responses to this question as shown in Table 6.1, were that of the 258 respondents, 153 (59%) use PowerHEDA; 39 (15%) use Microsoft BI technologies; 30(12%) use ITS and Oracle Discoverer; 20(8%) use In-house BI development, 10(4%) use Oracle BI Suite and 6(2%) have no BI system at all at their institution.

BI Technology	Number of Respondents	Percentage
PowerHEDA	153	59%
Microsoft Technologies	39	15%
ITS and Oracle Discoverer	30	12%
Oracle BI Suite	10	4%
In-house BI development	20	8%
No BI System	6	2%
Total	258	100%

Table 6.1: Business Intelligence Technology Used in South African Universities

The decision taken was to deploy the CABIF in the PowerHEDA environment and use the Microsoft SQL Server for the data architecture. The choice was based on the high frequency of 59% of the respondents using PowerHEDA. The other reason was that Univen is also one of the institutions using PowerHEDA and has the Microsoft educational license for Microsoft SQL Server databases. Univen has the Integrated Tertiary Software (ITS) as its

Enterprise Resource Planning System, which is an Oracle based technology. This implies that, the researcher had to create a data migration solution to get data from Oracle environment into the Microsoft environment. This will be shown in the next section, in CABIF implementation.

6.3 Case Study at University of Venda

As has been mentioned earlier, at Univen there are multiple database platforms, for the ITS ERP system and other legacy systems. The Microsoft SQL Server and Oracle are two separate database systems that are supporting distinct applications, at Univen. The researcher needed to integrate the two database platforms, as most of core business operations are captured in ITS environment at Univen. The researcher could not build any BI tools or execute lookups, queries, and other operations on one database that does not integrate data from the other database platform. As the SQL Server database required ad-hoc database access to Oracle, a **linked server** was used. The Microsoft SQL Server's '*Linked Server*' functionality effortlessly assist to integrate the SQL Server applications with tables, indexes, and views stored in Oracle. The researcher needed to have all the necessary conditions setup for the two database platforms to be able to communicate. One of the conditions for creating an SQL Server linked server to an Oracle database platform is to install the Oracle Client software on the Server housing the SQL Server database. In the following section, all the prerequisites for migrating data from ITS environment to SQL Server are enlisted.

6.3.1 The Architecture of the Business Intelligence System at Univen

The software requirements as listed in Table 6.2 include, the BI server running Windows 2012 Server 64-Bit Edition with latest patches, SQL Server 2014 Business Intelligence Edition with latest software patches. The Hard drives included two hard drives with at least 100GB capacity each and one with a minimum of 75GB storage capacity. The first hard drive was for the operating system and Internet Information Service (IIS) web server, the second was meant for the SQL databases including the Reporting Services and the third drive was for the Analysis Services Server. The Random-Access Memory (RAM) of the server should be at least 16 GB to accommodate and handle the traffic on the server. The Microsoft .Net all versions from 3.5 to the latest versions. The Oracle Client Software for was needed by the researcher to be able to access the Oracle databases.

Before the researcher created an SQL Server 2014 linked server to Oracle, the researcher installed the 64-Bit Oracle 11g client software on the 64-Bit SQL Server 2014 BI Edition system. The Oracle client software provides the network libraries that are required to establish connectivity to the Oracle database. Installing the Oracle client software on the SQL Server system enabled the researcher to connect to the ITS environment's Oracle database server. The researcher tested the installed Oracle 11g database server and confirmed that it was functional. When the researcher selected and downloaded the Oracle client software, he was careful to get the appropriate client for the SQL Server system's 64-Bit processor architecture. That is why the researcher downloaded the Oracle x64 client.

System Requirements	Version and Capacity
Operating System	Windows 2012 Server 64-Bit
Database Platform	64-Bit SQL Server 2014 BI Edition
Hard Disk Storage	2 X 100GB; 1 X 75 GB • 100GB Operating System and IIS • 100GB SQL Databases and Reporting Services • 75 GB Analysis Services Server
Random Access Memory (RAM)	16GB
Oracle Client	Oracle 11g client
Microsoft. NET platform	Microsoft. NET Versions 3.5 - 4.5

Table 6.2: Software Requirements for the BI System at University of Venda

Figure 6.1 shows the resultant hard disk configuration of the BI Server infrastructure at the Univen. The first hard drive was for the operating system and Internet Information Service (IIS) web server and has a capacity of 268GB, the second for the SQL databases including the Reporting Services is 568GB and the third drive with a capacity of 1.26TB is for the Analysis Services Server, including backups. This shows that the BI Server infrastructure at Univen exceeds the minimum requirements this researcher listed in Table 5.2. In addition to the configuration of the Server, the researcher also configured the SQL Server logon security to Mix Mode (this includes Windows and SQL). The collation of the SQL Server was set to SQL_LATIN1_GENERAL_CP1_CI-AS.

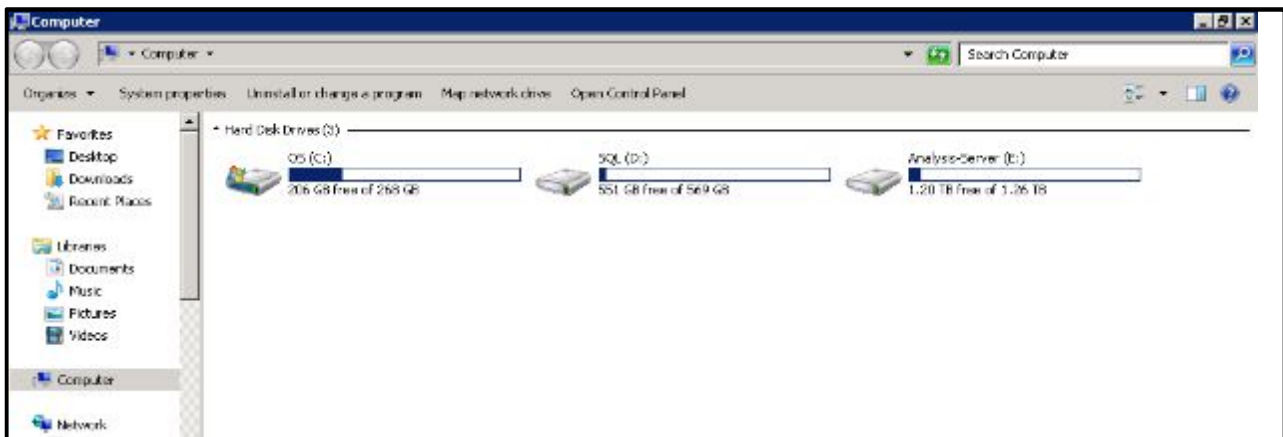


Figure 6.1: Hard disk configuration of the BI Server infrastructure at the University of Venda

The researcher also needed to be granted permissions to be able to access the ITS Oracle data using the Oracle client. The access to the ITS database Tables and Views could only be granted by AdaptIT, the proprietors and software vendors for ITS. In this researcher's personal communication with Thomas Potgieter, the Senior Database Administrator at AdaptIT on 16 August 2014, the access to the schemas in the ITS system using the following script, were granted.

```
CREATE ROLES its_heda
*** Role Created
CREATE USER heda identified by heda123 default tablespace P01PRT
TEMPORARY TABLESPACE TEMP
*** User created
GRANT its_heda to heda
*** Grant succeeded
ALL GRANTS
SELECT 'GRANT SELECT ON' || owner || '.' || table_name || 'TO its_heda; FROM
dba_tables WHERE owner IN ('STUD','FINC',
'RPT','GEN','PLACE','ASSET','PERSON','DBAS','LIB','MED','MISS','CARD
','KMAN','WEB','PCM')
SED TNSNAMES adapter resolve alias Attempting contact (DESCRIPTION=
(ADDRESS_LIST= (ADDRESS= (PROTOCOL=TCP)
(HOST=integratorodb.Univen.ac.za) (PORT=1521))) (CONNECT_DATA=
(SERVICE_NAME=prodi01.Univen.ac.za))) OK (0 msec)
```

After the researcher was granted access to the ITS database server, the Oracle client was installed and the researcher subsequently created the linked server. When the Oracle client was installed it gave the researcher three installation options. These were Instant Client, the Administrator, or the Runtime components installation options. The Runtime option which

by default required 483MB of hard disk storage space was chosen. This Oracle Client installation option installs the Oracle OLE DB Provider, the ODBC driver, SQL Plus, the Configuration Assistant, and the Net Manager, which are the basic components needed to configure the Oracle client. These are also the basic components that are required to create an Oracle linked server within an SQL Server environment.

The script received from Thomas Potgieter from AdaptIT, gave the researcher access to all the schemas in the ITS environment. As an example, the Schema '**FINC**' contains finance databases, the schema '**STUD**' contains student information and the Schema '**PERSON**' contains staff information. All the Schemas and their respective database tables were imported into the linked server which was named '**UNIVEN_ORA**', denoting that its Univen data from the oracle database. The data from the linked server was subjected to Extraction, Transformation and Loading (ETL) processes using SQL Server Integration Services (SSIS) packages to produce a SQL Server data warehouses and SQL databases as shown in Figure 6.2.

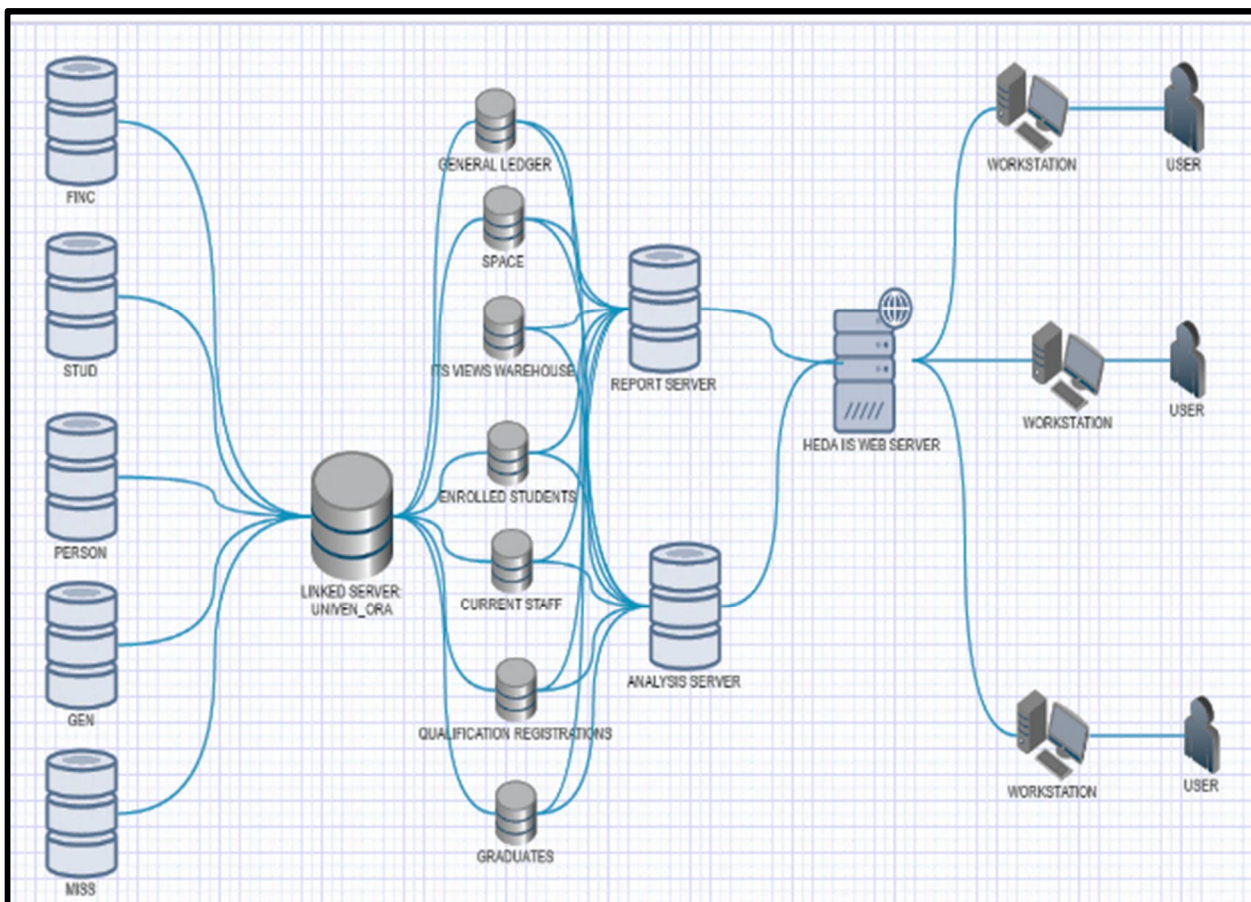


Figure 6.2: BI architecture implemented at University of Venda

The BI architecture implemented at Univen as shown in Figure 6.2 entails importing data from the various ITS Oracle databases into the SQL linked Server. These databases were

then extracted from the SQL Linked Server, transformed and loaded into various data warehouses in the SQL Server environment, through SSIS packages. The data assets in the SQL Server environment were then converted into SQL reports through the SQL Server Reporting Services (SSRS) or into multidimensional cubes through the SQL Server Analysis Services (SSAS). These reports either in the form of analysis cubes, or and SQL reports are rendered to the users through the web, as IIS is configured for such purposes. The Univen data assets which hail from all the institutional business processes, where stored in the data warehouses in the SQL Server environment. An example is the ITS Views Data Warehouse which the researcher created and is shown in Appendix D20. The data architecture functional group of the BI Context of CABIF need to support data focussed activities for designing and loading all data assets require to support BI.

The idea of a BI system is to have all data assets from disparate data sources to be stored in one place for further analysis. The data sources at Univen are not only from the ITS system. The HEMIS data used for statutory reporting is another vital source of information, as all the statutory reports rely on it. During the research, the researcher noticed that there were also individual shadow systems in the form of Spreadmarts, especially Excel spreadsheets, within Univen. These spreadsheets were also sources of data that needed to be imported and they subsequently form part of the broader BI data architecture. The data warehouse architecture in the SQL environment was crucial at Univen. The HEMIS data were enriched with other institutional data sources for a comprehensive reporting mechanism. This researcher combined all these data sources and come up with a BI architecture at Univen as represented in Figure 6.3.

The architecture shows that the HEMIS ASCII files, operational data from ITS, data from shadows systems are enriched, staged and developed into an enterprise-wide data warehouse. The data from the data warehouse is extracted, loaded and transformed into multidimensional databases. The users are then presented with reports through the web, and are assisted in their decision-making processes. The InterrogatorPro triggers are used for data quality processes, and data records that are found with data quality issues are e-mailed automatically to the data custodians. The PowerHEDA server is configured with a service e-mail account that is used to send e-mails to the various data custodians. Appendix D19 shows the complete multiplatform BI architecture implemented at the University of Venda.

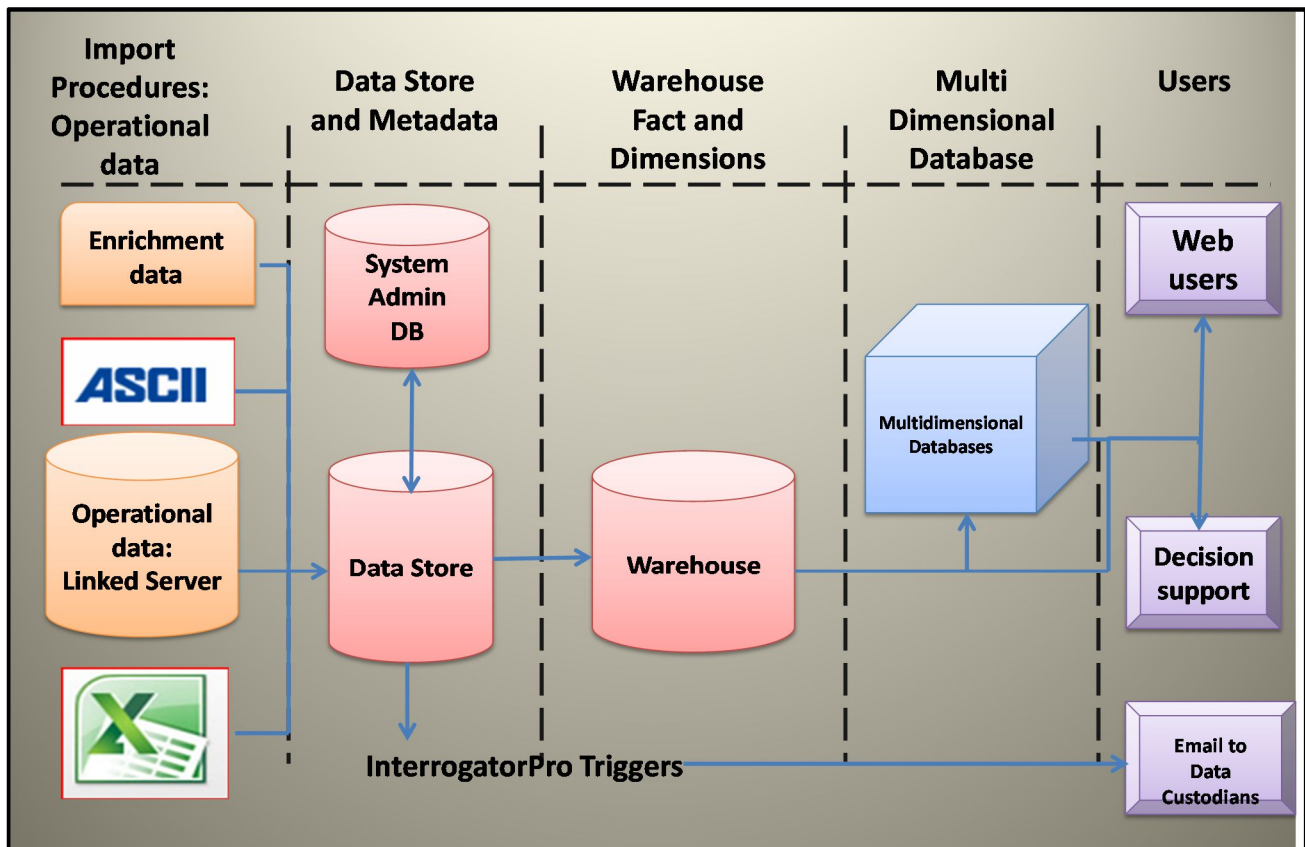


Figure 6.3: Logical BI Architecture at University of Venda

6.3.2 Implementing the Context-aware Business Intelligence Framework

The following Table 6.3 shows how the CABIF contexts were maximised for enrolment management business process at the University of Venda. The CABIF assist Univen by providing targeted information at the time is central to improving the enrolment management decision-making processes. The users no longer spend all their time building reports, are provided with analysed report that they can use for academic administration. One fact for sure is that the ITS ERP system is not designed for information retrieval and analytical processing. The ERP system is practically used to store discrete business transactions and has minimal integrated reporting systems. The information and reports from the ITS environment cannot be retrieved using multiple ways and the reports do not integrate data from its multiple databases. The utilization of analytical tools within the ITS platform is very minimal, and in order to reach such a level, the knowledge and skills to use business analysis is vital. The implementation of a BI tools, within the institution, whether they are large or small systems they require a framework. The BI framework, as CABIF has demonstrated consists of a data warehouse architecture, data governance, change management, training users, communication plan, support, and an implementation strategy.

CABIF Context	Description
Basic Context: Premise	Approved Academic Programme - Requirements Specifications - Business metrics / Key Performance Indicators
Process Context: Macro-Activities	Enrolment Planning
Process Context: Micro-Activities	- Applications, Admissions, Registrations - Student Tracking - Cohort Analysis - Enrolment Management
Business Intelligence Context	Data Sources - Databases and/or Views - Data warehouse - Data Store, Schema type, Description Functional Requirements - BI Use Cases - Workflow of the analytical processes BI Application - BI dimensional model design - Data Integration design
Business Intelligence Skills Context	IT Skills - Data Acquisition - User Interaction - Data integration - Queries, Stored Procedures - Report building and presentation Analytical Skills - Knowledge of Analytical algorithms - Data mining - Prediction and forecasting - Extrapolation Business Skills - Business constituency identification - Business content expertise - Business priorities, concerns and issues - Identification of existing reports and shadow systems
Governance Context	Regulatory and Compliance Requirements - POPI ACT - Technical requirements - Requirements cross-matrix Data Governance - Data Quality requirements specifications - Data Cleansing - Master Data Management

Table 6.3: CABIF contexts for enrolment management at the University of Venda

A more detailed practical demonstration of CABIF at Univen, is the longitudinal tracking of 2005 first time cluster enrolment students. The longitudinal study falls under the student cohort analysis institutional research activities. This researcher used the CABIF to develop and derive a detailed report on the cohort year. The longitudinal cohort analysis are studies that looks on how students persist in a qualification (progression), how they are retained in the system (retention), or whether they drop-out or stop-out from the qualifications (attrition). In essence longitudinal cohort analysis assist in academic administration, teaching and learning and enrolment planning activities. In this case the researcher has chosen the academic administration business area, and is specifically looking at enrolment management. It is also important to note cohort analysis can also be time-series studies. The Table 6.4 illustrates the researcher's attempts to use CABIF in resolving this practical example.

CABIF Context	Description
Basic Context: Premise	2005 First time cluster enrolments
Process Context: Macro-Activities	Enrolment Management
Process Context: Micro-Activities	Cohort Analysis
Business Intelligence Context	Data Sources - Data warehouse [SCHEMA] [HEDA DATA WAREHOUSE] - STUDENT_DIM (ITS VIEWS WAREHOUSE) - TIME_TRACKING_FACT - TRACKING_CLUSTER_DIM - TRACKING_STATUS_DIM
Business Intelligence Skills Context	IT Skills - Data Acquisition - Data integration - Queries, Stored Procedures - Report building and presentation Analytical Skills - Knowledge of Analytical algorithms Business Skills - Student persistence, attrition and retention
Governance Context	Regulatory and Compliance Requirements - POPI ACT Data Governance - Data Quality requirements specifications - Data Cleansing

Table 6.4: CABIF Contexts for Student Cohort Analysis

The following SQL script draws up the student retained, stop-out, graduated, and dropped-out studied over a period of eight years.

```

DECLARE @Cohort_year SMALLINT = 2005, --Cohort Year
        @Tracking_year SMALLINT = 2005 --Tracking year
SELECT TD_Cohort.td_529 [CohortYear],
       TD_Tracking.td_529 [TrackingYear],
       tcd_e04 [TrackingClusterCode],
       tcd_e228 [TrackingCluster],
       tcd_005 [QualyTypeCode],
       tcd_005_desc [QualTypeDescription],
       tcd_053 [MinTime],
       sd_007 [StudentNumber],
       [tsd_e425] [TrackingStatus],
       [tsd_e423] [TrackingStatus2]
FROM [HEDA_Warehouse].[dbo].[tracking_fact_1]
LEFT JOIN heda_warehouse.dbo.student_dim
      ON sd_pk = tf_sd_fk
LEFT JOIN heda_warehouse.dbo.time_dim TD_Cohort
      ON TD_Cohort.td_pk = tf_td_cohort
LEFT JOIN heda_warehouse.dbo.time_dim TD_Tracking
      ON TD_Tracking.td_pk = tf_td_tracking
LEFT JOIN heda_warehouse.dbo.tracking_cluster_dim
      ON tcd_pk = tf_tcd_fk_cohort
LEFT JOIN heda_warehouse.dbo.tracking_status_dim
      ON tsd_pk = tf_tsd_fk
WHERE TD_Cohort.td_529 = @Cohort_year
      AND TD_Tracking.td_529 = @Tracking_year
ORDER BY TD_Cohort.td_529,
         TD_Tracking.td_529,
         tcd_e04,
         [tsd_e425],
         [tsd_e423],
         sd_007

```

The researcher did not include the detailed results of the script as it shows the student unit records shown by the **StudentNumber** field, this is because of the research ethics protocol which, the researcher indicated that no student unit records, will be displayed or disclosed

in the study. The summarised results are shown in Appendix D16, as SQL report developed using the SQL reporting services. The researcher then fully respond to all the research questions the researcher was trying to answer at Univen.

6.3.3 Detailed Responses to the Research questions at the University of Venda

In response to the question, *“How is the existing technology infrastructure leveraged to accommodate a university-wide business intelligence based management information system?”* The researcher can say that by creating a linked server in the SQL Server environment, the researcher harnessed all the institutional data assets in the ERP system. This researcher also used the existing licences for Windows Server, SQL Server, and PowerHEDA reporting tools to implement the CABIF, without asking for extra budget or technology. In such a way, the researcher managed to leverage the existing ICT infrastructures and proceeded with the rest of the research. The BI architecture shown in Figure 5.3 is just showing a generic BI solution at Univen and is acting as a background to the practical implementation of CABIF at Univen. A complete BI solution is shown in Appendix D19.

The question, *“what information presentation formats constitutes reports that facilitate decision making processes within the institution?”* requires the researcher to give the reporting tools of the BI system. These are the BI tools which present the analytics subjected to the BI data architecture. In this research, analytics in the BI system refers to the models, tools and methods that assisted the researcher in extracting the data from the institutional core business data assets. The analytics assisted in identifying the patterns and anomalies in the data, it stimulated the researcher to pose and answer further institutional research questions about the institutional business processes and strategies. The researcher managed to present the reports as multidimensional cubes, SQL reports, scorecards and dashboards.

The SQL reports came directly from the SQL Server Reporting services and were rendered in the web BI portal through the browser. The multidimensional cubes which were the product of the SQL Server Analysis Services, were also rendered in the browser, but these had the capabilities to choose a variety of parameters. Both the SQL reports and cubes had data visualization capabilities through charts and graphs. The SQL reports were more static, and cubes were more dynamic with filter and drill-down functionalities. The dashboards and

scorecards presented the data in a visual way, and they displayed the current status of institutional core business processes. The scorecards presented performance indicators and some benchmarks in a visual way. The dashboards and scorecards were primarily targeting executive managers.

6.3.3.1 The Viability of Academic Entities at the University of Venda

Institutional planning activities requires various metrics to be considered. One of the metrics that is important to consider is the financial contribution of academic entities. The aim of exploring the financial viability of academic entities is not to spark a debate about the usefulness of qualifications or academic departments within the institution. In this researcher's view, that would be a means to an effective and efficient implementation of a resource allocation model within the institution. At Univen in response to the question, "*how do various managers monitor the contribution of their entities through the implemented business intelligence solution?*" the researcher created a suite of reports herein referred to as the viability reports.

An example is illustrated in Appendix E1, the contributions made by all academic entities at Univen. Using the various data drivers such as teaching input units, teaching output units, research graduates outputs, tuition fees, staff FTEs etc., this researcher managed to convert to Rand value each of these data drivers. This researcher managed to use the account mappings supplied by the Finance Directorate at Univen, and showed the income and expenditure of the academic entities for the 2011 and 2012 academic years. These data drivers can be drilled down to School and to the department level. This viability report is useful for budgeting purposes and resource allocation. The report can also inform the institution in developing effective student recruitment strategies as they compare contributions made by the qualifications in the different funding grids. The data drivers allow the academic entities to compare with each other and assist each other to improve.

The work done on the viability of academic entities at Univen, allowed this researcher to also answer the question, "*What indicators allow academic entities to compare their performances in different functional areas?*" The data drivers listed in Appendix E1, are examples of indicators that academic entities at Univen can use to compare their performance to each other. The researcher would like to point out that these data drivers, that is, the KPIs are drawn from the core institutional business process at Univen. These core institutional business processes are teaching and learning, research and community

engagement. In this research, the researcher did not exhaust fully the KPIs from these three core institutional business processes at Univen but tried to extract more than 15 KPIs from teaching and learning and research.

In this study, the researcher tried to demonstrate how an individual programme generates its subsidy income using the Student Enrolment Plan as the point of departure. Thereafter, the student fees are added to determine the total income (first and second stream income). In this research, all forms of third stream income were disregarded. The researcher subscribes to the view that, once Univen has a clearer understanding of its income generators and cost drivers disaggregated down to programme level, it will have informed basis for its decision making and resource allocation. However, the limitations of this approach was that it did not factor in the strategic value of a programme, scarce skills categories, the requirements of the National Development Plan or the imperatives of the White Paper on Post-Secondary Education (2013). Equally so, it did not factor in the outcomes and output factors such as graduate employability, graduate destination and starting salary and graduate satisfaction surveys.

6.3.3.2 Forecasting Government Block Grants at University of Venda

The bulk of the income at the University of Venda comes from the State subsidies and block grants. In this study, the researcher merely intended to clarify how SAHEIs are funded and how institutional subsidy income is generated. This researcher tried to go one step further to disaggregate income generation to programme level. The block grants are a government funding of higher education institution element, which are undesignated amounts to cover the operational costs of higher education institutions, and linked to the provision of teaching and research-related activities. Block grants are council-controlled funds, which can be used at the discretion of council and the university management. Both block grant calculations and progress reports of earmarked funds depend heavily on reliable audited HEMIS data submitted annually by universities to the Department (Asmal, 2003a).

This researcher wants to define key terms used for calculating block grants and these include teaching input units, teaching output units and research output units. It is also important to note that the teaching input grant depends on the CESM categories, and these are passed into the funding grid based on the weightings by the course levels. The teaching output grant depends on the weightings of the qualification types of non-research degrees. The research output grant depends on the weighting of research graduates and publications.

Teaching Input Units:

These are the institution's total FTE enrolled students for any funding year. The institution's teaching input units for the calculations for the teaching input grant are considered as follows:

- (a) The institution's total unweighted HEMIS FTE enrolled students for year (n-2) is taken as proxy for its approved total of FTE student places for year (n) subject to the following adjustments:
 - I. To correct HEMIS student data errors
 - II. To make the n-2 total consistent with either student rolling plans approved by the Minister of Higher Education and Training or
 - III. Other conditions laid down by the Minister.
- (b) The adjusted FTE total enrolments for year (n-2) are passed through the grid which is approved on a rolling three-year basis by the Minister of Higher Education and Training. This grid places FTE enrolments into categories which are weighted according to:
 - I. Course material
 - II. Course level
 - III. Instruction-delivery mode (DoE, 2004)

Teaching output Units:

These are the institution's total graduates for any funding year. The institution's teaching output units for the calculations for the teaching output grant are dependent on:

- (a) An **actual** total of non-research graduates and diplomats for year n-2, and
- (b) A **normative** total of non-research graduates and diplomats which it should have produced in terms of national benchmarks
- (c) The keys steps in the calculations of the teaching output grant is as follows:
 - I. The institution's output of non-research graduates and diplomats for year (n-2) are weighted in accordance with a grid approved by the Minister of Higher Education and Training on a rolling three-year basis. The resulting total is the institution's actual weighted total of the teaching outputs for funding year (n-2).
 - II. The normative total of the teaching output units is based on the institution's headcount enrolments for year (n-2) and a set of benchmarks approved by the Minister of Higher Education and Training on a three-year rolling basis.

- III. The outcome of the benchmark calculation is a normative total of graduates/diplomats, which must be passed through the weighting grid (DoE, 2004)

Institutional Factor Grants

The institutional factor grants are grants allocated by the Minister of Higher Education and Training to institutions with large proportions of disadvantaged students. The disadvantaged students are deemed to be African and Coloured students, who are South African citizens and who are enrolled either in contact or distance education programmes offered by dedicated distance education institution.

- (a) For funding year (n), calculations are made for each institution of the proportion which African and coloured students are South African citizens have of their total unweighted FTE contact student enrolment in year (n-2).
- (b) Calculations are also made for the dedicated distance education institution of the proportion which African and coloured students who are South African citizens have of its total unweighted FTE student enrolment.
- (c) The institutional factor operates by adding an amount to the teaching input grants of the institutions, depending on what their proportions are of disadvantages students.
 - I. A calculation is made of the teaching input grant generated by an institution's contact students, and a proportion is then added to this contact teaching grant
 - II. In the case of dedicated distance education institution, a calculation is made of the teaching input grant generated by its distance students, and a proportion is then added to the distance teaching grant.
 - III. These proportions are approved by the Minister of Higher Education and Training on a rolling three-year basis (DoE, 2004)

Research Output Grants

The DHET advocates that research resources should be concentrated in the institutions where a considerable research capacity or potential has been demonstrated based on approved mission and programme profiles. Research funding in HEIs is determined solely based on the research outputs. The research output grants are determined based on the following:

- (a) Publications units
- (b) Research masters and doctoral graduates

- (c) The calculation of the research output grant is based on the actual publication units and research graduates of year n-2.

The allocation of research funds to institutions is determined on the basis of two sets of research output calculations, which are as follows:

- I. An **actual weighted** research outputs of year n-2 produced by each institution. The weighting of the research publication units and research graduates is based on a grid approved by the Minister of Higher Education and Training on a three-year rolling cycle.
- II. A **normative weighted total** of the research outputs, which each institution should have produced in accordance with the benchmarks laid down by the Minister of Higher Education and Training. The normative total of research outputs is based on the institution's permanently appointed instruction/research staff for year n-2, and a set of benchmarks approved on a three-year rolling cycle by the Minister of Higher Education and Training
- III. The annual research output grant of an institution will be based on the proportion its actual total represents of the normative total for the system.
- IV. Any shortfall between the institution's normative and actual research output maybe allocated to it as a research development grant based on a submission of an approved research development plan (DoE, 2004).

Earmarked Grants

The earmarked grants are a government funding of higher education institution element which are designated amounts to cover the specific costs of higher education institutions linked to the provision of specific activities as determined from time to time by the Minister of Higher Education and Training. Earmarked grants require annual progress reports to be submitted to the DHET. Reporting on finances (e.g. expenditure data) within progress reports is required (Asmal, 2003a; DoE, 2004).

The allocation of the earmarked grants is determined by:

- (a) The total quantum of public funds available in a given year for higher education
- (b) The teaching and research related activities, as well as other objectives, that the Government expects the public higher education system to deliver.

In the initial stages of this research, this researcher managed to simulate the funding formula in an Excel spreadsheet using the Ministerial Statement on University Funding: 2015/16 and

2016/17 (Nzimande, 2014b). The researcher the asked IDSC for a programmatic way to determine the financial allocation at Univen, and they sponsored the researcher with the Financial Allocation Model (FAM), see Appendix E2. The FAM extracted data from the HEMIS Data warehouse in the BI Data Architecture at Univen and calculates the block grants using the information supplied by the Minister in the Funding Statement. An example of the report generated using the FAM is on Appendix E3. The report uses the 2012 HEMIS data to forecast the funding Univen received in the 2014/2015 financial year. At the end of the report, one can see that Univen exceeded the $\pm 2\%$ threshold allowed by DHET, see Appendix E3. This could lead to the institution being penalised as it might be that it is claiming more funded credits than agreed upon with the Minister. This report is useful for institutional enrolment planning activities as well as the budgeting process.

In response to the question, *“how useful is the business intelligence application in providing a forecast of the block grants from the Department of Higher Education and Training?”* This researcher can say that the BI system can be used effectively to forecast government block grants effectively, when there is provision to input the funding allocations metrics supplied by the Minister of DHET, as can be shown in Appendix E3. This can be done through creation of web forms, that will receive input from the Ministerial statement on University Funding, and TIUs, TIOs and ROs are directly retrieved from the BI Data architecture. In this research, the researcher used the FAM, but this application has some licensing implications to the institution. The other way is to use Excel spreadsheets after extracting the data from data warehouse and predict the funding, but this requires skills and takes a bit of time.

6.3.3.3 Measure and Monitor Performance at University of Venda

One of the important institutional activity in SA higher education is strategic planning, and the DHET requires institutional Mid-Year Performance Reports and Annual Performance Reports (Nzimande, 2014a). The Annual Performance Plans (APP) linked to the institutional strategic plan is a statutory requirement and each HEI in South Africa has to comply. In a quest to answer the question, *“How can the institution measure and monitor performance in key business processes?”* this researcher used the Annual Performance Plan Monitor (APPM) application of the HEDA suite, see Appendix E2. This researcher asked for this application as a means of leveraging the existing technology within Univen. The aim was not market or promote the HEDA applications, but to seamlessly integrate existing IT

resources within Univen. The approach was to use the theoretical and practical foundations of CABIF, to respond to this question.

One of the key institutional planning business process is strategic enrolment planning (SEP). SEP has been a major force in the South African higher education, both in the institutional organization and practice of higher education. Effective SEP assist institutions in efficiently maximising the allocation of institutional resources. In response to this question, this researcher will take strategic enrolment planning and management at Univen as one the key business process that a CABIF based BI can be used to implement. Figure 6.4 shows how this researcher translated the DHET enrolment KPIs into actionable information sets in the BI system at the University of Venda. The Ministerial student enrolment planning targets as agreed upon between the Minister and the Council form part of the Institution's Annual Performance Plan to be submitted by 15 December each year (DHET, 2014b). Council needs to submit a mid-year report and an annual report providing progression in terms of the approved annual targets of the institution. Each HEI in South Africa is required to list the core performance indicators and any other chosen indicators. The institutions are also required to provide a summary of plans in meeting its identified critical strategic success factors.

The researcher then fed the 2014-2019 DHET enrolment Plan which Univen had agreed with the Minister of Higher Education and Training into the APPM. The DHET 2014-2019 was supplied to the researcher on 24 November 2015, as an attachment in an e-mail communication by Professor Crafford, the Deputy Vice-Chancellor Academic at the University of Venda. The researcher formatted the Excel spreadsheet, for uploading into the MS SQL based APPM. When the researcher formatted the spreadsheet, there were 254 KPIs in the DHET enrolment plan. These KPIs were clustered into the following groups: Access, Success, Efficient and Research Output KPIs as outlined by the DHET for annual institutional performance reporting.

Dashboards and Reports

The researcher build a dashboard that consisted of widgets, which display the current status of the metrics and DHET enrolment plan key performance indicators (KPIs) for Univen. The dashboard as shown in Appendix D18, consolidate and arrange actual DHET enrolment plan KPI metrics on a single screen. The dashboard has been tailored in such a way, that each widget is showing the main KPIs in the enrolment plan. The DHET KPI dashboard has

the ability to pull real-time data from the APPM databases. This researcher also developed an SQL report that can map the actual values of the KPIs against their targets. The APPM provided the opportunity to assign responsibility roles against the KPIs. The other report which is very, important is that snapshots of how the institution is performing against its targets can be taken anytime. The snapshot facility is important especially during the drafting and development of the DHET Mid-Year Performance Reports. An example of the DHET enrolment plan performance report is shown in Appendix 17.

The DHET enrolment dashboard the researcher developed, permits Univen managers to scrutinize the contribution of the various academic departments to the student enrolment plan. This is an effective and efficient mechanism to gauge exactly how well the institution is performing against its enrolment targets. In such an instance, Univen will be able to measure the efficiencies and inefficiencies, with respect to the DHET KPIs targets. The DHET KPIs dashboards allows Univen to encapsulate and report specific KPIs data points within the institution thus providing a "snapshot" of the accomplishment of the KPIs. The dashboard is also an effective way to detect and amend any negative trends regarding the KPIs. The DHET KPI dashboard also provides a visual presentation of the key performance indicators, and makes it easier for Univen to notice any anomalies.

In conclusion, this researcher can say that, the current BI solution at Univen, can be modelled using CABIF to provide monitoring and measuring institutional performance on key business processes. The DHET KPI dashboard facilitates as also an effective tool, for Univen managers to make more informed decisions based on the gathered business intelligence. This would facilitate Univen to align its strategies with the institutional goals. The visibility of all the DHET KPIs is offered instantly through the dashboard, in such a way that any outliers and even correlations can be identified quickly.

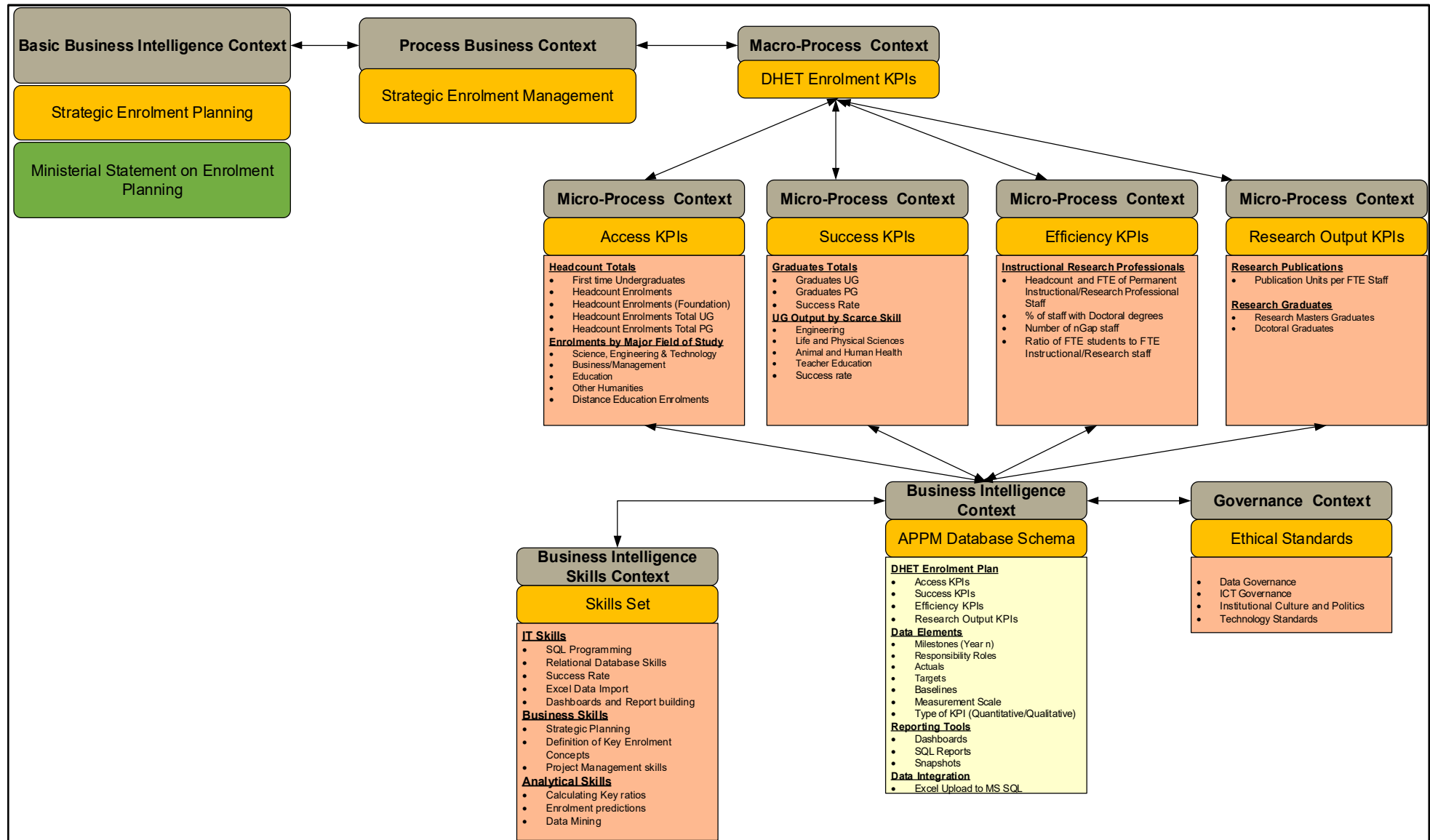


Figure 6.4: DHET Strategic Enrolment Performance Monitoring Using CABIF

6.3.3.4 Business Intelligence Acceptance at the University of Venda

At Univen, the researcher further explored the user's adoption and acceptance of the BI tools and applications implemented through PowerHEDA reporting and portal management front-end. This question is also marked the culmination of the deployment of BI tools using the developed CABIF. This researcher deployed a BI technology acceptance survey at Univen. The researcher designed the survey with one question soliciting the Age group of the respondents; seven Perceived Ease of Use (PEU) characteristics; seven Perceived Usefulness (PU) characteristics; four Attitude Towards Using (ATU); characteristics; four Intention to Use (IU) characteristics; four Facilitating Factors (FF) characteristics; and five Actual Usage (ACTUAL) characteristics. The basic assumption made in the case study at Univen was that the age, experience and facilitating factors will have positive affect on the business intelligence system users' motivation. These determinants are considered in the formulation of the following hypotheses:

Hypothesis 1: There is a negative relationship between perceived usefulness and (a) age of the user and (b) race of the user when using the Context-aware business intelligence solution at University of Venda.

Hypothesis 2: There is a positive relationship between the experience of the user and (a) perceived ease of use and (b) perceived usefulness for using the Context-aware business intelligence solution at the University of Venda.

Hypothesis 3: There is a positive relationship between attitude towards use (a) perceived ease of use and (b) perceived usefulness the of the business intelligence solution.

Hypothesis 4: There is a positive relationship between intentions to use the BI system and (a) age, and (b) attitude towards use of the Context-aware business intelligence solution at University of Venda.

Hypothesis 5: There is a positive relationship between the actual usage, and (a) facilitating factors and (b) intention to use of business intelligence solution at the University of Venda.

The researcher then started to explore and test each of the hypothesis using regression analysis. Before performing regression analysis, the researcher performed correlation

studies on linked nodes of the TAM. This exercise yielded the results that are presented in the next sections.

a) Results of the Technology Acceptance Survey at University of Venda

The data analysis for the TAM survey at Univen was initially done using SPSS in 2015 and in 2016 the researcher used PSPPIRE, because there was no license for SPSS. PSPPIRE.exe is a *GNU pspp 0.9.0-g745ee3* variant, which as a program for the analysis of sampled data, and is endorsed by the Free Software Foundation. The software analysed data the same as accurate as SPSS does. The software reads 'SPSS.sav' files and it was easy for the researcher to repeat the same analysis done using PSPPIRE. The researcher measured the internal consistency (reliability) of each of the measures in the TAM survey using Cronbach's alpha statistic. The correlations among the variables and regression analysis, were used to explore the variables represented in each of the five-hypothesis mentioned earlier.

b) Detailed Results

The researcher collected a total of 257 records of the respondents from the Univen community after a three rounds of e-mail communications. The initial examination of the data showed that two records with missing or incomplete responses, and the researcher expunged the two records from the final set of data the researcher analysed. The resultant analysis of the TAM survey at Univen was therefore carried out on 255 records. The Table 6.5 shows the demographics of the respondents.

Valid cases = 255; cases with missing value(s) = 0.						
Variable	N	Mean	Std Dev	Range	Minimum	Maximum
Kindly indicate your age.	255	35.05	8.91	30.00	25.00	55.00

Table 6.5: Demographics of the Respondents at the University of Venda

c) Reliability and Validity Tests

This researcher then assessed the validity and the reliability of the data from the responses from the TAM survey at Univen and yielded Table 6.6. The validity and reliability was done using Cronbach's alpha.

Variable	Cronbach's alpha
Perceived Ease of Use	0.70
Perceived Usefulness	0.54
Attitude Towards Using	0.91
Intention to Use	0.81
Facilitating Factors	0.624
Actual Usage	0.84

Table 6.6: Reliability and Validity of the TAM data set

The researcher did not adjust any of the variables or do any coding to the data set in order to gain more reliability alpha statistics for any variable. The model yielded satisfactory reliability results, which were quite positive. This researcher then performed further analysis of the TAM data set at Univen by creating combined variables for each of the TAM variable. The combined variables were based on the mean of each of the observed/latent variable in each TAM variable group. The new variables were created based on each of the following constructs Perceived Ease of Use (PEU); Perceived Usefulness (PU); Attitude towards Use (ATU); Intention to Use (IU); Facilitating Factors (FF); and Actual Usage (ACTUAL). A correlation analysis was run based on each of the constructs and the results are presented in Appendix E4. The correlation values corresponding relevant to the seven paths for the technology acceptance and adoption at Univen are indicated in Figure 6.5.

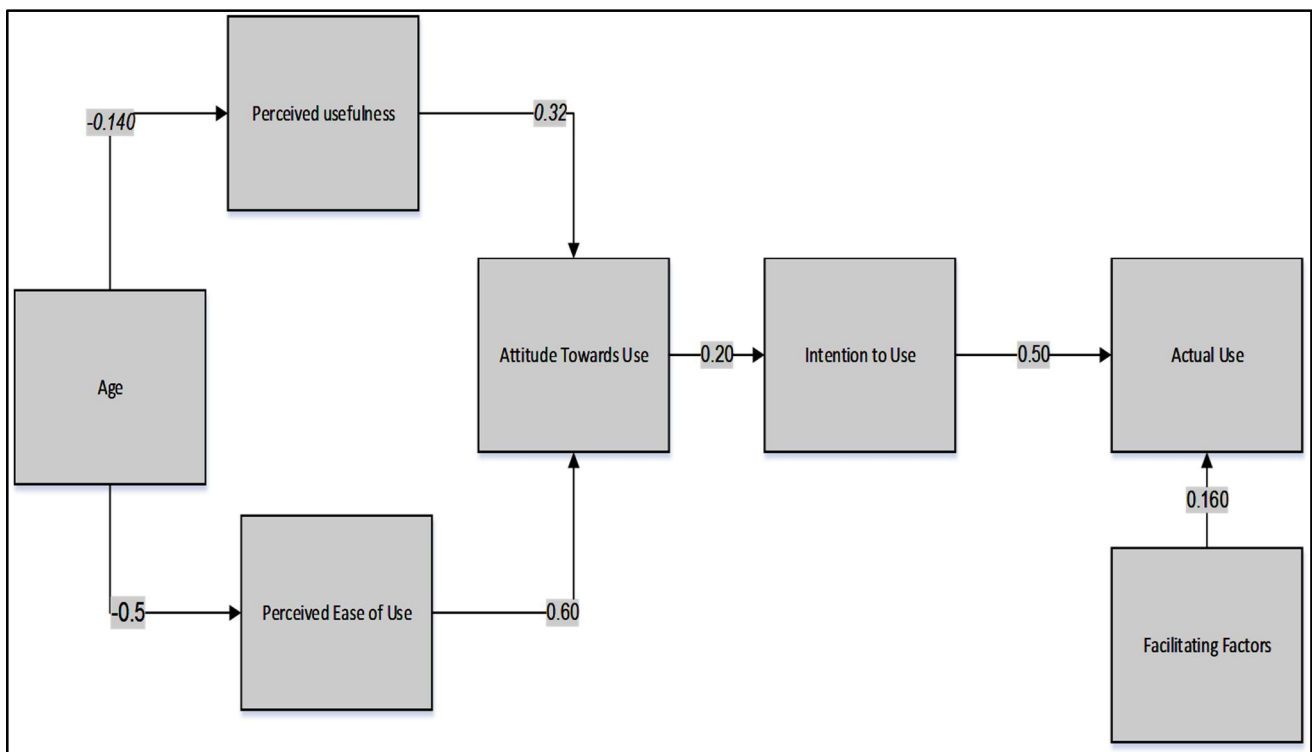


Figure 6.5: Pearson's Correlation Values between TAM variables

Regression Analysis on the Univen data set

The researcher ran a series of regression analysis on the TAM data set, based on a set of independent variables and a single dependent variable. The regressions were basically run with two independent variables and one dependent variable. The following set of tables bear the results of the regression analysis carried out.

a) Dependent variable: **PERCEIVED EASE OF USE**

R	R Square	Adjusted R Square	Std. Error of the Estimate
.144 ^a	.021	.013	8.855

Predictors: (Constant), AGE, RACE

b) Dependent variable: **PERCEIVED USEFULNESS**

R	R Square	Adjusted R Square	Std. Error of the Estimate
.055 ^a	.003	.001	0.373

Predictors: (Constant), AGE, RACE

c) Dependent variable: **ATTITUDE TOWARDS USE**

R	R Square	Adjusted R Square	Std. Error of the Estimate
.32	.10	.010	0.35

Predictors: (Constant), PERCEIVED EASE OF USE, PERCEIVED USEFULNESS

d) Dependent variable: **INTENTION TO USE**

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.20	0.04	0.03	0.36

Predictors: (Constant), AGE, ATTITUDE TOWARDS USE

e) Dependent variable: **ACTUAL USE**

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.16	0.02	0.02	0.35

Predictors: (Constant), FACILITATING FACTORS, INTENTION TO USE

6.3.4 Discussion of the TAM Survey Results at University of Venda

The results showed a strong Pearson correlation among the observed variables of the TAM survey at Univen. The Pearson correlation for the Perceived Usefulness of the BI system ($r=0.712$) and the Perceived Ease of Use of the BI system ($r=0.683$). These variables both correlate very strongly with the Attitude towards Use of the Business Intelligence System. This data used in conjunction with R-square and adjusted R-square of 0.021 and 0.013 support the hypotheses 1 and 2. Therefore, it means that there is a negative relationship between perceived usefulness and (a) age of the user and (b) race of the user when using the BI solution at University of Venda. The data also support the hypothesis that, there is a

positive relationship between the experience of the user and (a) perceived ease of use and (b) perceived usefulness for the business intelligence solution at the University of Venda.

The values of the Pearson correlation values attitude towards use and perceived ease of use (Pearson's $r=0.60$) and perceived usefulness (Pearson's $r = 0.32$), support hypothesis 3. The regression analysis of the data also support the results for the correlations with R-Square ($R^2 = 0.1$) and adjusted R-square ($R^2 =0.10$). The Pearson's correlation values between age and intentions to use the BI system at Univen is $r= 0.03$, while $r=0.20$ for the attitude towards use of the BI system and the intentions to use it. The regression analysis of the data also support the results for the correlations with R-Square ($R^2 = 0.04$) and adjusted R-square ($R^2 =0.03$). This data made the researcher to accept hypothesis 4, which states that, there is a positive relationship between intentions to use the BI system and (a) age, and (b) attitude towards use of the BI solution at University of Venda.

The values of the Pearson correlation values actual use and facilitating factors for the BI solution at Univen (Pearson's $r =0.16$) and intention to use (Pearson's $r = 0.05$) does not support hypothesis 5. The subsequent regression analysis of the data also support the results for the correlations with R-Square ($R^2 = 0.02$) and adjusted R-square ($R^2 =0.02$). This data made the researcher to reject hypothesis 5, which states that, there is a positive relationship between the actual usage, and (a) facilitating factors and (b) intention to use of business intelligence solution at the University of Venda. These low values prompted the researcher to reject the fifth hypothesis.

This researcher concluded that the BI tools deployed at Univen using the CABIF as a conceptual are acceptable to the users. This is because of the five hypotheses, generated using the TAM, only the fifth hypothesis was rejected, and this was because of the low Pearson's correlations variables and the resultant low R values. In response to the question, *"What is the end-users' perceived adoption and acceptance of the implemented business intelligence solution at University of Venda?"* This is an indication that, the BI solution at Univen has gained positive adoption and acceptance within the institution. However, judging with Pearson correlation values and corresponding regression analysis of the TAM variables the results for the correlations with R-Square and adjusted R-square need to yield values of higher magnitude as these were average. These results suggest that the promotion of BI at Univen should be aggressive and every manager need to incorporate BI tools in their decision-making processes.

In the next section the researcher would like to align and summarise the methodological implications of the research philosophy, strategies and approaches that were undertaken in the study. In that way, it will be able to show how CR and mixed methods research afforded the researcher to develop the CABIF within SAHEIs, and implement it at Univen. The analysis of the methodological implications of critical realism on the mixed methods research design opted, will touch some of the epistemological, ontological and humanist stances. This is also to corroborate the stance already taken, as the need for a philosophical diagnosis of the nature of the research problem in its reality space has been discussed in section 3.11.

6.4 Methodological Inferences of Critical Realism on Mixed Methods Research

In this research, the researcher has used critical realism as the philosophical underpinning of this research and a mixed methods approach, involving qualitative, quantitative and design science research methods in the same study. In this study, the researcher acknowledges that triangulation and multimethods have the same meaning as mixed methods and can be used interchangeably. In this study, the term mixed methods refer to the combination of qualitative, quantitative, and DSR in the same project. Retroduction as mode of analysis of the mixed methods research using CR as a theoretical framework has been applied very little (Zachariadis et al., 2013). In this study, the researcher adopted a more responsive and dynamic mode of research, because of the use of ontological and epistemological assumptions of CR. A responsive and dynamic mode of enquiry within the IS domain has been supported in the previous literature (Goes, 2014; Myers & Venable, 2014; Venkatesh et al., 2013; Zachariadis et al., 2013). This researcher's choice of CR and mixed methods research design was bound by reviewing the ontological, epistemological and methodological nature of the research problem. The link between the assumptions about the existence of the world and society (ontology) and the idea of how knowledge is possible and of what (epistemology), and the choice of methodological approach is paramount in CR according to Zachariadis et al. (2013).

6.4.1 Ontological Impact of Critical Realism

A strong emphasis on ontology and the idea of a reality (intransitive domain) which exists independently of our knowledge is supported by CR. This contrasts with the generation of knowledge as it is a human activity which is dependent on specific details and the associated processes of its production (transitive domain). The interpretation of the transitive domain

within this research's reality space established BI facts, theories, models, methods and techniques used by previous researchers in certain temporal and spatial reality spaces. CR assumes a stratified ontology which is divided into three domains: the real, the actual and the empirical. In this study the real domain included BI objects and structures with inherent causal powers and liabilities which resulted in BI mechanisms that were probably invisible. Zachariadis et al. (2013), defined a mechanism as a way of acting or working of a structured thing. The structured things being social processes or physical objects which possess causal (or emergent) powers. These causal or emergent powers when triggered or released, act as generative mechanisms to determine the actual phenomena of the world.

In this research, the researcher acknowledges that fact the not all of the generated BI mechanisms were not constantly empirically observable, but their value still existed even if they are exercised or not exercised. Consequently, the actual BI ontological domain is a subset of the real domain, and included BI events generated from both the exercised and unexercised BI mechanisms. The observable BI measures which were included in the survey deployed in SAHEIs, only included BI experienced events and changes. These bear witness to the powers and liabilities characterizing the BI structures, which constituted the generative mechanisms, which in turned resulted in the experienced BI events. The three ontological are presented in Figure 6.6 as adapted from Zachariadis et al. (2013).

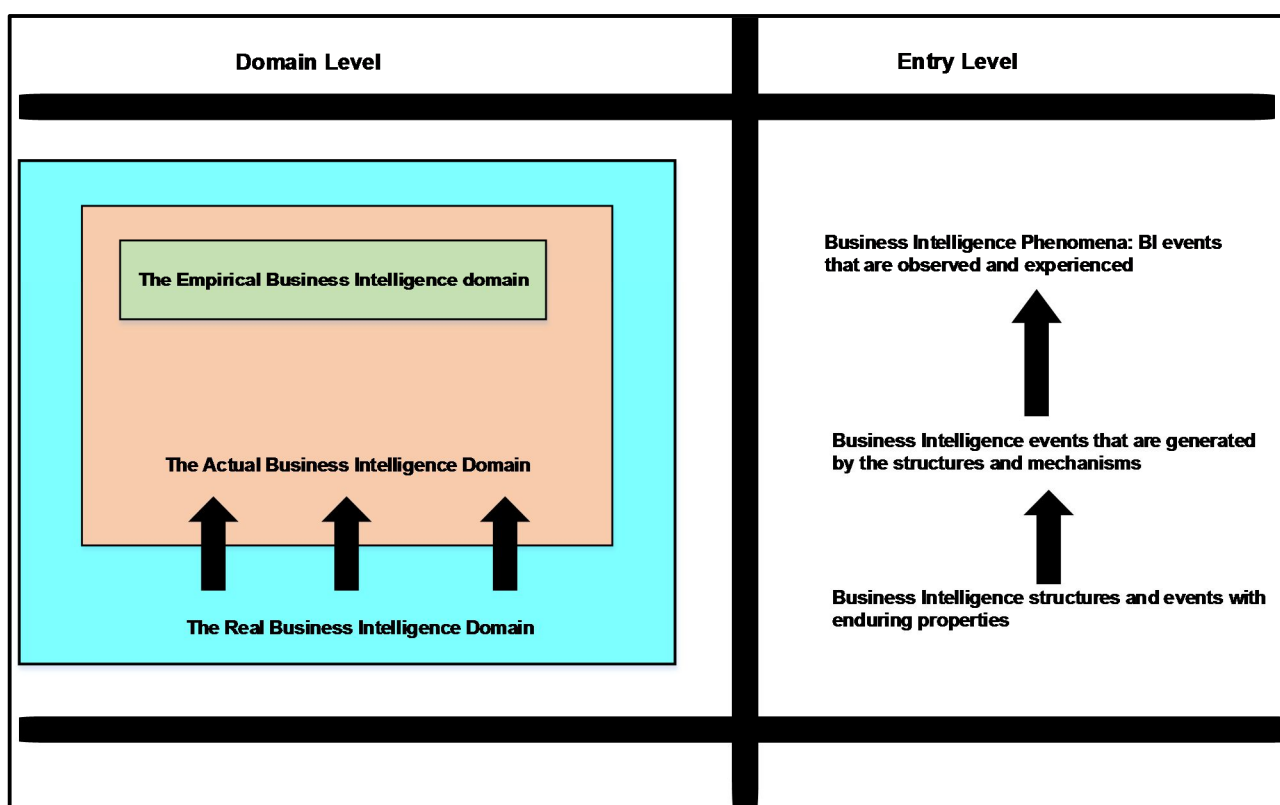


Figure 6.6: Stratified Business Intelligence Ontology for Critical Realism

The generative BI mechanisms within the SAHEIs were ontologically of key interest, because the researcher established the tendency of one generated BI mechanism to another. In the SAHEIs BI reality space, the researcher managed to ensemble BI structures, powers including relations within different BI attributes. This approach is in line with social laws, as the researcher assumed an assertion about the value of BI mechanisms within the SAHEIs, regardless of the conditions which they operated. The researcher achieved this because, CR afforded the researcher to assume that the SAHEI BI reality space is a complex and an open system, where other BI mechanisms and conditions also exist, based on the assertions made by Zachariadis et al. (2013). In that regard, the researcher attempted to look at the contexts and conditions of BI mechanisms within the SAHEIs, apart from an ensemble of BI structures, powers and liabilities.

6.4.2 Epistemological impact of Critical Realism

In an effort to explain the BI events within the SAHEIs, the CR view of causality of BI mechanisms within the SAHEIs BI domain space suggests that, the researcher had to explore and adopt other alternatives of making inferences. The exploration of CR literature suggested retroduction as an alternative logic of inference that could be used to postulate, identify, produce and explain BI mechanisms (liabilities and powers). Figure 5.7 shows that the CR retroductive approach to logical BI inferences, suggests that whichever research method the researcher used in underpinning the BI knowledge, lies in the empirical domain that is produced in the transitive domain.

The process of knowledge creation within CR in the BI domain and the place of retroduction within the SAHEI BI domain illustrated in Figure 6.7 has been loosely adapted from (Zachariadis et al., 2013, p. 858). This researcher's creation of BI knowledge using the retroductive approach for CR demonstrates its merit in accommodating different research approaches within the IS research domain. The dashed lines in Figure 6.7, indicate that the validity of knowledge is achieved using conventional methods and the continuous lines assume the CR validation of knowledge using retroduction. Retroduction per se has been described by Zachariadis et al. (2013), as a 'thought operation'. The retroductive approach also allows for multiplicity of research methods, where qualitative and quantitative research methods can be integrated to predict, identify and explain the generative mechanisms that cause the events we experience (Zachariadis et al., 2013).

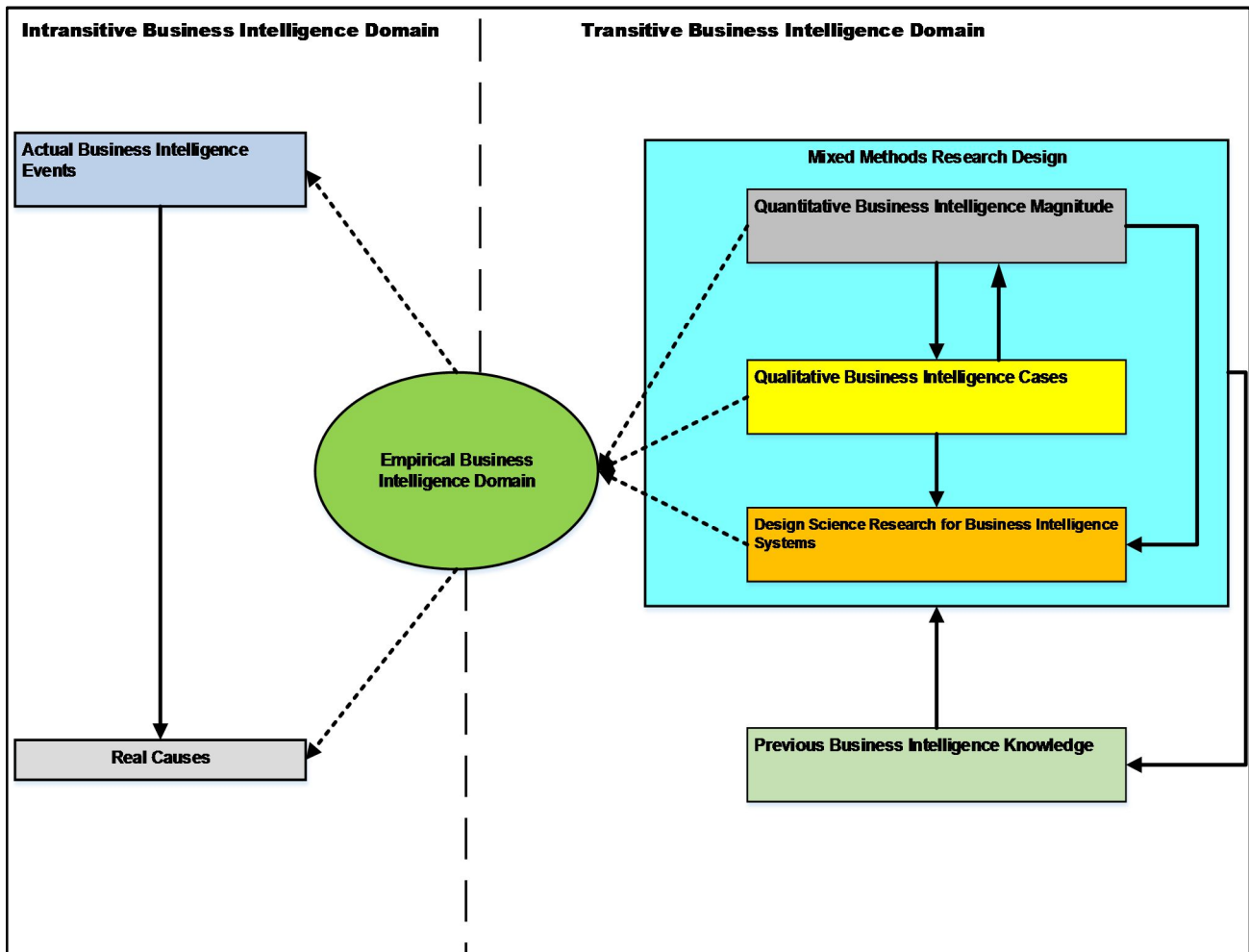


Figure 6.7: The Retroductive Approach of Critical Realism for BI knowledge Creation

This research produced the CABIF as the main theory and product of the study within the SAHEIs. This researcher needed to validate the quality of the BI inferences that were produced through the process of retrodution within the CR realm.

6.4.3 Validation of the Quality of Business Intelligence Inferences

The researcher's view of the validity of this research signifies the level of quality and rigour of the research the researcher undertook within the SAHEIs BI domain. The validity of the research, had significant impact on the quality of the BI inferences used to generate the CABIF. In this study, this researcher avoided to cause any confusion of the connotations of the validity of this research by adopting the classification proposed in Zachariadis et al. (2013) and Venkatesh et al. (2013). The point of departure was to look for common validation principles that are suited for both qualitative and quantitative research as mixed methods in IS research. The common research validity norms that are common in both strands of research are: design validity, measurement (or analytical validity) and inferential validity (Zachariadis et al., 2013).

In quantitative research, design validity broadly refers to internal and external validity. External validity signifies that correlation observed is causation and external validity means that the results can be generalized. The measurement validity refers to process of data collection and the reliability of the data and it reveals if there is any measurement error. Measurement validity also include construct validity which describes the degree to which the variables captured in the research model are measuring what they intend to measure. Inferential validity refers to the validity of the statistical conclusions and their sufficiency in making inferences.

In order to develop a common body of knowledge when using qualitative research scientists have a general consensus on the importance of validation. The agreed upon principles for qualitative research include how well the research was designed and executed (design validity); how well the data were collected and analysed (analytical validity) and finally how to assess the overall quality of the inferences and their interpretation (inferential validity). Analytical validity in qualitative research is used to conclude whether the data is dependable, consistent, and can produce plausible findings. However, as indicated in Figure 6.8, CR changes the centre of interest from empirical events behind causal mechanisms by contending that these could be autonomous and non-related.

Using CR in the SAHEIs BI, the researcher's quest was to establish whether the BI generative mechanisms uncovered were involved in the observed BI variables, which are denoted as BI events using the critical realist language. In this way, the researcher was not purely following the empirical paradigm which emphasize on internal validity of research. Likewise, the external validity of the research in the SAHEIs reality space was concerned with the generalizability knowledge claims of one or more BI causal mechanisms. These BI causal mechanisms caused the observable BI events in the research settings within the situated institutional contexts. These were similar to outcomes in the research reality space. Construct validity within the SAHEIs established the empirical traces that gave the researcher the actual BI events, which purportedly caused the generative BI mechanisms.

The conventional interpretation of the research validity focussed on the relationship between the BI theoretical constructs that were included in the BI survey deployed in the SAHEIs and their acceptance using the TAM survey at Univen. These are denoted by constructs 1 and 2 in Figure 6.8 and included are the 34 observable/measurable BI variables which existed

in the SAHEIs' BI empirical domain. Construct validity was concerned with the traces of BI research events and the information they gave when studying the observable BI constructs. These BI constructs, were indeed the manifestations of the BI latent variables which the researcher seek to uncover. The internal validity, demonstrated the different causations between the empirical observations, measured correlation matrix in PCA and the generative BI mechanisms represented by the BI factor loadings using varimax rotation. Finally, the researcher established the external validity when 15 generated BI mechanisms were generalized by subjectively naming them for the SAHEIs BI empirical domain.

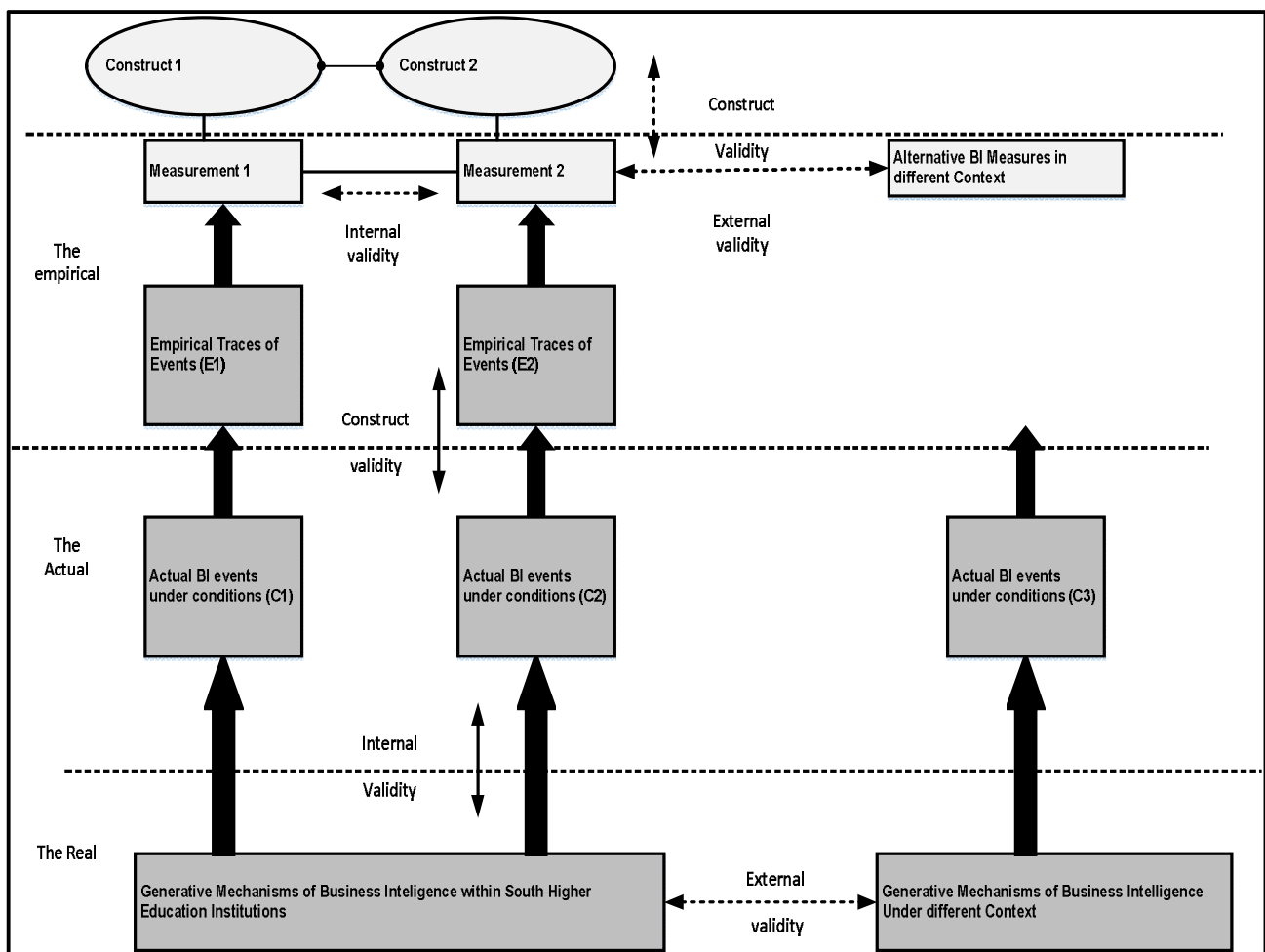


Figure 6.8: Research Validity based on Critical Realism

The subjective naming of the generated BI mechanisms could potentially be applied to different SAHEIs BI contexts, with different staff composition, institutional governance, and geographical locations and at different times. DSR allowed the researcher to further use the PCA results, prescriptive and descriptive knowledge and come up with the five constituents of CABIF. In that way, the researcher established that CR based mixed method design was valid as it allowed the researcher to study BI within multiple, dynamic, and shifting SAHEIs

contexts. In that way, the researcher managed to produce and reveal situated analytical contexts of CABIF within SAHEIs and using TAM at Univen as a single case study.

6.5 Summary and Conclusions

In this chapter, the researcher managed to leverage the outputs of the different strands of the research to explain the different BI contexts in different settings. The researcher refined the CABIF theory, by explaining the validity of the research through the explanation of the causal BI tendencies and the interplay of generative BI mechanisms and contexts within SAHEIs. The impact of BI within the SAHEIs could only be explained by separating external and internal BI contextual conditions within the sector.

The implementation of CABIF has been practically demonstrated at the University of Venda and an integrated BI system that leverage the current technology infrastructure has been suggested. The CABIF based BI system at Univen, has generally been accepted within the institution and this has been demonstrated through the deployment of the technology acceptance model. The use of BI to support core business processes such as enrolment management, monitoring the key performance areas embedded in the institutional strategic plan, forecasting government block grants, studying the viability of academic entities using a set of drivers has been demonstrated using the CABIF. The various reporting tools that range from scorecards, dashboards, cubes, and SQL reports have been shown and demonstrated in the BI solution at Univen.

This research has therefore shown exclusively at Univen, how the CABIF can be used to plan, design, develop and implement a business intelligence system within the South African higher education. The TAM at Univen, confirmed the theoretical contributions, of extending the basic TAM variables with the age of the respondents and facilitating factors to use the BI system. Thus this study has therefore broadened the variables used for technology usage, within the context of SAHEIs.

Chapter 7 : Conclusions, Recommendations and Further Research**7.0 Introduction**

In the first part of this research study, the researcher set out to explore the conceptual and theoretical foundations of business intelligence systems in the South African public higher education institutions. The study tried to reveal the conceptual foundations of the business intelligence frameworks, currently used in the SAHEIs, and to critically establish, if these technological entities are theoretically and practically contextualised. During the second part of the research, the researcher used the results of principal components analysis and design science research, as a means of deriving common entities and the theoretical underpinnings behind business intelligence systems used in the South African public higher education institutions. At this stage, researcher was in pursuit of developing a context-aware business intelligence framework suitable for the sector. The third and final part of the research set out to explore, how and what technology the context-aware business intelligence framework (CABIF) would be implemented as a vehicle for decision making processes at the University of Venda.

This chapter details the major findings of the research, and citing the implications of these findings to IS research and the broader academic community. The problems that were faced during the research will also be mentioned and the limitations of the research thereof. The researcher will also mention in this chapter the future research roadmap of this study. The chapter winds up by outlining some recommendations and give the autobiographical reflections of with respect study. The details the findings from the research study are summarised in the next section, succeeded by an overall evaluation of the research and the thesis.

7.1 Research Questions and Main Findings of the Study

The main empirical findings of this research were given in detail in the Chapter 4, “Data Analysis and Presentation of Results” and Chapter 5, “Implementation of the Context-aware Business Intelligence Framework”. In terms of the first research question, which set out to explore the conceptual foundations of the BI systems currently used by the SAHEIs, the researcher found out defragmented, non-coherent, and informal methodological approaches to the implementation of BI systems. The first research question which required the classification, clustering and cataloguing of scientific knowledge relating to the current SA

higher education BI applications and contextualize them in relation to theories and practices of IS research. This research found out that there is a hybrid of business intelligence applications and solutions within the sector and in some cases, there are no BI solutions at all. The first two research questions which this researcher explored were:

RQ1 *What are the conceptual foundations of the business intelligence frameworks currently used in the South African Public Higher Education Institutions?*

RQ2 *Are these Business Intelligence technological entities theoretically and practically contextualised?*

7.1.1 South African Higher Education BI Systems Conceptual Foundations

The research had shown that, South African public HEIs vary in the way the BI systems, are conceptualised and developed within each institution. The research findings show that the methodological framework or approach that was quite evident was the System Development Life Cycle (SDLC). This information systems design and development paradigm is used in generic software systems development initiatives. Thus, the SDLC applies to BI systems development, from a wider software engineering perspective. The fact that respondents from the SAHEIs, mentioned the SDLC as a methodological approach, it implies that other software development techniques such as the Boehm's Spiral Model, Rapid prototyping and Build and Fix development approaches may apply. The other BI design, development and implementation methodologies that came out during the research include agile development approach, conventional waterfall/cascade model, SQL programming, and vendor driven approaches were evident.

If one looks into the responses that mentioned SQL programming as a BI design and development methodology, then one will have more questions to explore. This researcher is of the opinion that, SQL programming is a programming technique that is used in interrogating the various data sets within the data architectural framework of the BI system. The data assets can be interrogated using other scripting languages such as PHP, VB Script, and ASP.NET etc. The choice of programming language to develop a BI system, should not be viewed as a methodological approach, but it should be justified as a technical choice. The BI systems development at some universities are following the modern agile software development approaches. This is quite interesting, as the agile software development paradigm contains a set of principles for software development in which, the

functional requirements and solutions grow through the partnership of self-organizing and cross-functional teams.

This research suggested the BI latent variable of business and technology alignment, and one can see that agile software development fits quite well within this BI dimension. Agile software development promotes adaptive planning, evolutionary development, early delivery of software products, and continuous software improvement. That means agile software development encourages rapid and flexible response to changes in the software. The problem with agile software development is that it does not have specific methods to achieve the development of a software in a quicker way. This research does not specifically show how agile software development is implemented within the institutions, with the exception of six respondents who mentioned “sprints” and “scrums”, as agile BI system development methodologies. The fact that other institution implement BI systems through the proprietors of BI solutions is worrisome, within the sector. This entails institutions being locked in by the BI vendor, and in this researcher’s view, have not done a proper situational analysis for their BI requirements.

7.1.2 Practical Foundations of South African Higher Education BI Systems

The intention to use PCA was to build a conceptual knowledge of business intelligence observable measures that could form the basis of a context-aware business intelligence framework, within the South African higher education sector. The researcher found out that, when performing PCA, it was characteristically a good idea to normalize the data first. The reason was that PCA seeks to identify the principal components with the highest variance, and if the data was not properly normalized, attributes with large values and large variances (in absolute terms) would end up dominating the first principal component when they should not. This principle coincided with the proposition made by Beaumont (2012) when PCA was done on exploring the reading skills of college students.

Almost all the HEIs in South Africa, have experienced the difficulty of mapping the diverse operational needs of the institution’s managers and departments to the requirements and institution-wide strategic goals in their BI systems. For many of the institutions, the conflicts between top-down (strategic) and bottom-up (tactical) approaches have sometimes become battlegrounds between the different lines of business. The research findings have shown that, these difficulties manifested themselves in the business and technology alignment strategies latent variable, and how each of the institution prioritizes these initiatives when an

abundance of bottom-up tactical approaches exist in addition to the top-down strategy. In naysayers' point of view superficially, it's easy to see why every higher education institution should already be implementing a theoretically and practically contextualised BI strategy. However, wanting this competency and actually making it happen are two very different things. The research findings agree with Halper & Stodder (2015), who stated that for BI ingenuities to become strategic, they need contributions and collaborations that are much wide-ranging in latitude than the average IT project, and they mandate primary buy-in and partnership between multiple business and IT entities across the institution.

The necessity for timely buy-in is exclusively spot-on for senior and executive management, but it also requires exhaustive support in each of the main decision-making areas well-known within the institution. In many South African higher education institutions, when it comes to a strategic BI initiative, politics and culture can effortlessly wreck a project. The results from the organizational and behavioural latent variable in this research, have shown that navigating politics and culture is always a key challenge. From a practical point of view, this research had shown that, some of the challenges institutions struggle with include, gaining user adoption; managing change; attainment of user acceptance, support, and consensus across executives, line-of-business managers, and IT. The research findings also found out that promoting and enforcing technology standards through strong governance and oversight by the various management teams in the institution is a challenge. The findings concur with those of Briggs (2014), who found out that, it was difficult to bring out a governance framework, when implementing a cloud-based BI at a Business Graduate School at Stanford University.

The data analysis have shown that most HEIs in South Africa, have an understanding of one or more of the basic elements of their corporate business strategies. This researcher's gut-feeling suggests that, the Department of Higher Education & Training has typically forced HEIs to define, at least on an annual basis, their top institutional strategic objectives and business units strategies (Nzimande, 2014a). They are now forced to analyse their niche areas within the higher education sector, determine their direction, and create plans to ensure that resources are available and stakeholders are informed. However, it is apparent that most HEIs do not sufficiently link these plans to their daily core business operations or manage execution effectively, with practical and theoretical context-aware BI systems Through this research, the researcher has recognized that BI technologies can be an enabler to successful lines of business execution in higher education, but, many HEIs do

not have in place their core business and IT alignment strategies. The core business and IT alignment strategies that allow institutions to plan their decision-making strategies via data-driven metrics and BI, or to map their institutional strategic objectives in order to effectively measure and monitor results to ensure that these institutional strategic objectives are achieved are seriously lacking. The research findings in this area have shown that this is an area which is either unheeded entirely, or applied on an informal basis in contradiction to regarding it as part of the basic success of the institutional core business strategy. The research findings also suggested that the need for a context-aware business intelligence framework for the SA higher education. The BI framework, which is theoretically and practically contextualised, is therefore needed in the sector. The findings from the PCA analysis coupled with design science research enabled this researcher to develop the CABIF. The research question which the researcher responded to was the following:

RQ3 *What Context-Aware business intelligence framework is suitable for the South African public Higher Education sector, and why?*

An analytical study of the information in the correlation matrices in terms of the underlying BI latent variables, and the observable BI measures within the SA higher education was done to perform a multivariate data analysis in the form of Exploratory Factor Analysis (EFA). The aim of EFA was to determine the latent structure of the BI dataset by discovering common BI factors (i.e., from the observed variables), which could potentially become the theoretical foundation of the BI systems. In this regard, EFA accounted for the common variance (i.e., the shared variance among BI observed variables). In the analysis done, the common variance was partitioned from its unique variance and error variance, so that only the common variance present in the BI factor structure remained. This means that the percentage of explained variance was reported in terms of common variance.

From the four BI Dimensions (latent variables), 15 BI factors were extracted from the 34 measured BI variables from both satisfactory and importance BI observed measures. The variance in the correlation matrix was “repackaged” into 15 eigenvalues. Each of the eigenvalue represented the quantity of the variance that was netted by one BI component. The first BI component accounted for the largest possible amount of variance. The second component, formed from the variance remaining after that associated with the first component has been extracted, and it accounts for the second largest amount of variance, etc. The principal components were extracted with the restriction that they were orthogonal,

because of the varimax rotation that this researcher chose. This research used PCA principally for BI variables dimensionality reduction, because if this researcher had not used for such purpose, the researcher would have discarded any principal components with zero or near-zero eigenvalues. The research findings for the second phase of the research was compounded by design science research to come up with CABIF. The CABIF contained the following structural components:

a) Basic Business Intelligence Context

The researcher established that there are basic contexts that a business intelligence framework within the SA higher education sector needs to fulfil. The researcher refers to the basic context of CABIF as the premise, these are the necessary conditions, where all BI activities start. The basic business intelligence context in this research refers to those BI features, or university core business drivers that are most necessary and fundamental, from which other BI contexts evolve. The researcher referred to the fact that BI practitioners in SA higher education should be aware or sensitive to the Basic BI Context. This context forms the basis for the BI framework, and the springboard for subsequent BI contexts within the CABIF. In this research, the researcher referred to the **academic programme/qualification** and its associated institutional and statutory compliance imperatives as the basic context for the CABIF.

b) The Business Process Context

The research findings have shown that an institution with a BI and analytics stratagem empowers its employees, by giving them the credible information timeously and allows them to make noble decisions. The researcher found out through the fact that almost 100% of the respondents strongly agreed that it was important for the top business areas to be addressed by the BI system. The BI and analytics approach should not only address the information needs of the whole institution, it should also align IT and the lines of business. Through DSR, the researcher divided the process context of CABIF into two components, which were named the **Macro-Process context** and the **Micro-Process context** respectively. The macro-level process context within SAHEIs are those business processes that are large and are capable of generating complex large data sets. The research findings suggest that, these lines of business processes within higher education require to be broken down to lower levels of granularity for a BI program to be successful. In this research the micro-

process context of the CABIF refers to small scale business processes which are sub-processes of the macro-process context. The design science research findings indicated that each macro-business process context can contain a number indestructible micro-process business contexts. These micro-business processes may generate individual data sets in the main BI data architecture.

c) The Business Intelligence Context

The Business Intelligence Context of the CABIF consists of a collection of BI features that encompass and shape the whole BI strategy at the SA higher education institutions. This research unpacked this context of the CABIF by unveiling the functionalities of BI systems, the technology infrastructure, and selecting the right technological choices for the system. The BI context allows for the institution to assess the business drivers from the institutional core business areas to be addressed, and align these with the technology. In this research, the researcher had the BI latent dimensions/variables, and the observed BI measures within these dimensions, which assisted in defining the BI metrics within the framework such as data management, information delivery, data analysis framework (data mining and including analytics), the data architecture which included data marts and data warehousing. The BI context of CABIF, is regarded as the hub of the technology and core business alignment strategies within the institution.

d) The Business Intelligence Skills Context

The research findings proposed the Business Intelligence Skills Context of CABIF as consisting of an aggregate of business skills, IT skills and analytic skills. The researcher suggests that leveraging IT skills, business skills and data analysis skills is key to the success of any BI initiative within the SA higher education. The analytical skills include being able to forestall business issues and produce analytical models to deal with them. People with analytical skills can determine correlations, regressions, trends, patterns etc. on the available core business data assets. This research also suggests that, the IT people should be able to bring forth ways to support institutional core business and data analysis requirements, by providing means of accessing and managing institutional core business data assets.

A contingent of people with IT skills for BI, are also capable of selecting BI technologies and tools, developing the data warehouse and assist in data

management and administration. The researcher also suggests that, BI specific software knowledge is crucial, which include, experience and proficiency in SQL programming. SQL is the programming language used for data definition and manipulation of the data assets. The Data architecture which include data marts, data warehouses and database tables are primarily developed using SQL. The reporting tools, like SQL reports, multidimensional reports, data sets and perspectives for dashboard are developed using the SQL programming language. The people with business skills should have the knowledge and understanding of the various institutional business units. These people should also have adequate know-how to align strategic BI goals with institutional goals and express them undoubtedly to the institutional executive management. People with business skills work collaboratively with LOB managers on developing return of investment models on BI, BI business cases and the prioritization of activities.

e) The Governance Context

The research findings noted that the South African HEIs as government institutions have to abide by the ICT governance standards, gazetted by the Department of Public Service and Administration (DPSA). This concurs with the observable high correlations in the data governance, technology standards and ICT governance BI measures which were included in the survey. The institutional governance of ICT incorporates the assessment and guiding the attainment of strategic goals and by means of ICT. BI governance maybe taken from a programmatic view, but in actual fact it is embedded in the institutional ICT governance, and it permits the accomplishment of institutional core business processes by provisioning the opportunity for data governance. The success of the BI project within the institutions depends on the collaborative partnerships between IT, core business people, and the executive management. This research suggests that, the joint BI application design, development, deployment and ongoing support will make the BI project a success.

f) Business Intelligence Roadmap

The CABIF is a theoretical framework for the conceptualization of BI initiatives in the SA higher education. This research suggests a further operationalization of the CABIF, and develop a sequence of steps that the institutions need to follow when designing, developing and implementing BI systems. The researcher refers to these

logical steps as the BI roadmap for SAHEIs. The BI roadmap for SAHEIs, should not be viewed as a set of sequential steps, but it includes iterative steps and it should be viewed as a BI life cycle (BILC). This approach is also in line with the software engineering paradigmatic approach of SDLC, which has been referred to by some of the respondents of survey on BI in the SA higher education sector. The researcher implemented BI reporting tools using the CABIF, at the University of Venda, based on BI roadmap. The research findings at Univen, were based on addressing the third and fourth research questions, which are:

RQ4 *How can CABIF be rolled-out as a vehicle for decision making processes at the Univen?*

RQ5 *What technology can the Context-Aware business intelligence framework (CABIF) be implemented as a vehicle for decision making processes at the Univen?*

a) Technology for implementing the Business Intelligence Solution

The researcher took the decision to deploy the CABIF in the PowerHEDA frontend environment and use the Microsoft SQL Server for the data architecture as the backend. This choice was based on a high frequency of 59% of the respondents using PowerHEDA. The other reason was that, Univen is also one of the institutions using PowerHEDA and has the Microsoft educational license for Microsoft SQL Server databases. Univen has the Integrated Tertiary Software (ITS) as its Enterprise Resource Planning System, which is an Oracle based technology. This implies that the researcher had to create a data migration solution to get data from Oracle environment into the Microsoft environment.

b) How was the Technology Implemented at the University of Venda?

The BI architecture implemented at Univen entails importing data from the various ITS Oracle databases and schemas into the SQL linked Server. These databases were then extracted from the SQL linked Server, transformed and loaded into various data warehouses in the SQL Server environment using SSIS packages. The data assets in the SQL Server environment were then converted into SQL reports through the SQL Server Reporting Services (SSRS) or into multidimensional cubes through the SQL Server Analysis Services (SSAS). These reports were either analysis cubes, or SQL reports, and were rendered to the users through the web, as IIS was configured for such purposes. The Univen data assets which hail from all the

institutional business processes were stored in the data warehouses in the SQL Server environment.

c) Leveraging existing technology infrastructure at University of Venda

The linked server, created at in the SQL Server environment at Univen connected all the institutional data assets in the ITS ERP system. The fact that, the researcher used the existing licences for Windows Server, SQL Server, and PowerHEDA reporting tools to implement BI tools based on CABIF at Univen, without asking for extra budget or technology, showed that the researcher managed to leverage the existing IT resources at Univen. In such a way, the researcher managed to leverage the existing ICT infrastructures and proceeded with the rest of the research.

d) Business Intelligence Outputs at the University of Venda

The analytics subjected to the core Univen business data assets, yielded reports in form of multidimensional cubes, SQL reports, scorecards and dashboards. The SQL reports came directly from the SQL Server Reporting services and were rendered in BI web portal through the browser. The multidimensional cubes which were the product of the SQL Server Analysis Services, were also rendered in the browser, but these had the capabilities to choose a variety of parameters. Both the SQL reports and the cubes could be exported to Excel Spreadsheet for the user to customize reports on their own. Both the SQL reports and cubes had data visualization capabilities through charts and graphs. The SQL reports were more static, and cubes were more dynamic with filter and drill-down functionalities. The dashboards and scorecards presented the data in a visual way, and they displayed the current status of institutional core business processes. The scorecards presented performance indicators and some benchmarks in a visual way. The dashboards and scorecards were primarily targeting executive managers.

e) Key Performance Indicators Used to Compare Academic Entities

The researcher used the CABIF implemented BI solution at Univen to distinguish and compare the viability of academic entities at Univen. The researcher drew up standard KPIs for academic departments such as Student FTEs, teaching input units, teaching output units, graduation rates, success rates, teaching output grant, teaching input grant, Instructional Research Staff to Student Ratio. These are just a

sample of the indicators that were used at Univen to compare the performance of academic entities against each other. The KPIs were extracted from the core institutional business process at Univen. These core institutional business processes include teaching and learning, research and community engagement. Although the researcher did not exhaust fully the KPIs from these three core institutional business processes at Univen, more than 15 KPIs were extracted from teaching and learning and research key performance areas. These comparisons of KPIs are a recipe for institutional planning activities.

f) Forecasting Government Block Grants

The research findings confirmed that the CABIF implemented BI system at Univen, can be used effectively to forecast government block grants when there is a provision to input the funding allocations metrics supplied by the Minister of DHET. This can be done through the creation of web forms, that can receive input from the Ministerial statement on University Funding, and TIUs, TIOs and ROs are directly retrieved from the BI Data architecture. In this study the FAM was used, but this would have licensing implications to the institution. The other way is to use Excel spreadsheets after extracting the data from the data warehouse and predict the funding, but this requires skills and takes a bit of time. The findings suggest leveraging the existing PowerHEDA reporting frontend by using the FAM is a modelling tool for government block grants. These allocations can be used in the institutional budgeting planning process.

g) Strategic Performance Measurement and Monitoring

The Annual Performance Plan Monitor (APPM) application of the HEDA suite, can be used to input the whole Strategic Plan, and Institutional Annual Performance Plans linked to the Strategic Plan. The researcher got this application from IDSC the company the developed the PowerHEDA frontend. It was also viewed as an opportunity to leverage the existing technology within Univen. It is important to note that, the aim of this exercise was not market or promote the HEDA applications but to seamlessly integrate existing IT resources within Univen. The researcher managed to input and extract the 254 KPIs for the Strategic Enrolment Plan (SEP) of Univen and input it into the APPM. The actuals against the targets are compared for each year and a dashboard showing the key performance metrics of the enrolment plan

was developed. The researcher concluded that, the existing data architecture could be used to extract the actual enrolment KPIs against their targets. This serves to consolidate the relevance of BI system implemented using CABIF, especially in monitoring and measuring institutional performance indicators.

h) User Acceptance and Adoption of the Business Intelligence System

The researcher concluded that, the BI tools deployed at Univen using the CABIF as a conceptual and practical BI framework are acceptable and adoptable by the users. This is because of the five hypotheses that were generated using the TAM, only the fifth hypothesis was rejected, and this was because of the low Pearson's correlations of the variables and the resultant low R values. The researcher can securely say that, the BI solution at Univen gained positive adoption and acceptance within the institution.

However, judging with Pearson correlation values and corresponding regression analysis of the TAM variables the results for the correlations with R-Square and adjusted R-square needed to yield values of higher magnitude as these were average. These results suggest that the promotion of BI at Univen should be aggressive and so that every manager need to incorporate BI tools in their decision-making processes. The study at Univen included measurable BI characteristics such as user adoption strategies, and user training strategies, and these were loaded with high correlation values. The high correlation values imply the users' value training in using the BI system its use for a broad spectrum of users.

7.2 Implications of the Research Findings

The research findings have a direct impact on the contribution to the theoretical and practical foundations of BI within the South African public higher education sector. The fact that the researcher used empirical methods to derive to important BI characteristics, and use DSR to build the CABIF artefact, demonstrates the researcher's ability to contribute to the broader scientific knowledge. The researcher has shown that, sequential mixed methods research in information systems are feasible, realistic and plausible. The research, has also demonstrated that, DSR is a strong research methodology that can be deployed within the field of IS. The researcher will now show how this work contributes to knowledge, practice and to policy.

a) Contribution to the body of BI knowledge in SAHEIs

In the past, South African higher education institutions based their decisions on gut feeling, and in most cases intuitively using simple data observations (Mutanga, 2015). The siloed approach using Spreadsheets as the data architecture was rampant. Apart from contributing to theory and practice in information systems, this research contributes to how SAHEIs can use business intelligence to understand a lot of data, synthesizing information that is valuable and allowing for data analysis and predictive analytics. This research can enable information technology practitioners in South African higher education, to learn the related business intelligence jargon and contextualise it within the sector based on a methodological approach. The CABIF contain the important nuggets for BI design, development and implementation within the South African higher education sector. In Section 6.2.3, the researcher will extend the contributions of the study to the broader BI domain.

b) Contribution to practice in SAHEIs

South African higher education institutions have to adopt the culture of evidence as a driver to improve their core businesses which include teaching and learning, research and community engagement. The term culture of evidence refers to the institution's ability to know and show exactly how its stakeholders (staff, students, council etc.) interact with the institution. As an example, students move through the institution, from their first day at the institution, through to graduation, to reach their educational goals. Ideally, the data and information derived from the transactions with students is used to improve institutional processes, drive sound decision-making, and provide accountability to external and internal stakeholders, including to the students themselves.

The establishment of integrated Management Information Systems in higher education institutions can make it possible to create a data architecture for storing the data extracted from the Transactional Information Systems and subject it to various analyses to make sure that all levels of management can access it. The CABIF highlight all the contexts needed to put into practice how a successful BI system can be practically designed and implemented at a SAHEI. This research advocates for aligning business and technology, look at the organizational structures including harnessing all IT, business and analytical skills to make an integrated and

viable BI solution. The research does not only look at tying together core business processes with IT but all advocates for standard governance frameworks that will enable a successful BI at any South African higher education institution.

c) Contribution to policy within South African Higher Education

With this study, the researcher hopes to provide an impetus for higher education executives and management to develop sound data governance policies and develop information technology strategies that will align with the core business of the institutions. The issue that this research addresses issues of leveraging existing technology infrastructure, it implies the search for a goodness of fit for BI technology with the rest of the enterprise IT infrastructure. The link to the overall ICT governance framework such as COBIT, and King IV Corporate Governance framework, is an ideal impetus for strategic focus on BI at SAHEIs.

7.2.1 Evaluation of the Theory Generated Through the Study

The evaluation criteria used here was established in Section 3.3 through to 3.11. These sections touched issues related to what constitute theory, the philosophical underpinning of the research, research paradigms, philosophical groundings and how to diagnose the nature of the research problem in its reality space using a philosophical lens. These attributes and others that came out during the study, will be used to evaluate the theory generated by this research. The next sections will therefore, cover broadly some of the criteria used in evaluating the contributions of the thesis to the wider BI body of knowledge.

7.2.2 Research Quality Considerations

In Section 5.4.3, the researcher discussed and reviewed the BI causal mechanisms produced by retroduction of critical realism within the SAHEIs BI space. The implications of using retroduction for the validity and quality of the logical BI inferences produced within the SAHEIs' reality space, have an impact on the quality of the research. The conventional methods of the research validity particularly for research using mixed methods change in the realms of CR. The validation of research within MM in IS research made the researcher to conclude that the research was of good quality. The high values of communalities, the Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy, quantified important characteristics of the research model. The acceptable statistics of these values that measured important validity metrics of the research settings,

entails the structure or objects of the research were of good quality. The high values of Cronbach α , also reflect the reliability of data, hence the high quality of the research.

The extensive use of methods to identify and establish demi-regularities with the data patterns which were subjected to DSR, uncovered BI mechanisms, important agencies, and social structures within the SAHEIs that produced observable BI behaviours. The researcher had shown that using the retroductive approach of CR, the mixed method research design showed a systematic BI picture within the SAHEIs. Design science research assisted in generating meta-inferences of CABIF, with specific examples for strategic enrolment planning, cohort analysis and forecasting government block grants at Univen. From a critical realist point of view the actual BI events within the SAHEIs settings, showed the manifestations of CABIF, for certain generative BI mechanisms within certain institutional contexts. This entails the design validity was acceptable. The results of PCA used to theorize the BI mechanisms within the SAHEIs, provided explanations for the BI events that occurred, hence it was analytically valid. The degree of external validity of the research was subject to distinguishing between the BI contingent factors from the crucial ones. For this research, it was not logical to discuss about the impact of CABIF within SAHEIs, when it was not possible to separate the external or contextual conditions within the institutions.

The attempts to separate the CABIF contingent factors from the necessary ones within the SAHEIs, could only partially separate the contextual conditions from the internal (necessary) properties of BI. The reasoning and systematic conceptual abstractions of BI within the SAHEIs, made it possible to separate the external BI characteristics from the internal ones. This was an essential theorizing step taken, which led to the acquisition of BI knowledge that led to the development of CABIF. The researcher also needed to combine the theorizing steps with the descriptions of the BI empirical contingencies, within which BI causal powers have taken place within the SAHEIs. The findings from the qualitative and quantitative research strands of the study, which were fed into DSR to produce CABIF, demonstrates a sound inferential validity of the study. All in all, the researcher concluded that this research was of acceptable quality.

7.2.3 Contribution to the field of Business Intelligence System

Assessing one's own theory or research may prove to be very difficult, and therefore the researcher will try to be more objective. The researcher had already highlighted the significance of the research, by separating the BI domain within the SAHEIs. In that way the

managed to delineate the status quo of BI within the SAHEIs BI reality space, and expressed the significance of contextualism or situatedness within the sector. The CABIF is a theory, knowledge and solution while it can contribute immensely to BI design, development, and implementation within the SAHEIs. In this researcher's view, a BI solution signifies accrual of BI knowledge hence the two are inseparable.

Although maturity models have revolutionised the BI domain, their application in the higher education domain has been loosely reported. The JISC and the OCU have made significant attempts to theorise and put into practice BI conceptualizations into higher education. However, these are distinct from CABIF, in that, the researcher looked at the various institutional contexts to make BI assumptions. CABIF identifies and compartmentalizes the various BI structures, events and mechanisms into five BI contexts. The BI practitioners within the SAHEIs should be aware of these contexts, and can apply them relative to their institutional environments. The maturity models, which are more techno-centric, have been criticised through CABIF, which considered the value of institutional social structures and processes subjected to BI. In this study, BI contextualism or BI situatedness is key to the successful design, development, implementation and maintaining BI systems within the SAHEIs. The complete evaluation of this thesis is based on Mavetera (2011), who cited Introna (1992).

7.2.4 Evaluation of the Study's Contribution to the Body of Knowledge

The evaluation of the study will address the following questions:

a) Is the research problem addressed a persisting question in the field?

This study, focused on unpacking the mechanisms of how BI implementations work within the SAHEIs settings and contexts. This researcher, looked at what is it about BI implementations within the institutions, that works and for whom and why. This research study emphasized on a deep understanding of the BI contexts, settings, and mechanisms within the SAHEIs. The research also showed how a critical realist approach, using a sequential mixed research design can assist in developing the CABIF for the SAHEIs. The practical BI examples and testing of the various CABIF contexts using the TAM at Univen, was the researcher's attempts to perform an evaluative CR approach, and hence trying to establish the critical success factors for BI implementations within the SAHEIs.

b) Is the method of enquiry adopted suitable?

The research studies based on CR in IS research have been predominantly qualitative. A few research studies in the IS domain have capitalized the methodological pluralism advantages afforded by CR. The mixed research methods which used the quantitative (PCA) approach, the qualitative (content analysis) approach, and design science research proved to be suitable for researching the BI domain within the SAHEIs. The sequential mixed methods research design which was deployed, and the TAM at Univen ascertained to be an authentic approach to establish a body of knowledge of BI within the SAHEIs.

The SAHEIs BI survey, which explored the research participants' BI satisfaction and value of BI characteristics, and the open-ended questions gave strong insights of BI within the SAHEIs. The methodological choice of deploying design science research was absolutely suitable for the enquiry, as it is solution driven according to Carlsson (2011). The focus of DSR is the IT artefact, which was the CABIF in this study. The choice of DSR, justifies the fact that the field of information systems is basically about human activity systems, which are technologically enabled in most cases. The context of design and use of the developed IT artefact is crucial, and in this research, the researcher deployed research paradigms, practices and activities that established this worldview in designing, developing and implementing CABIF. CR embraces methodological pluralism as indicated by Zachariadis et al. (2013), and it is in the middle way between empiricism/positivism and anti-naturalism/interpretivism, therefore introducing a nuanced form of realist ontology.

The fact that this study is within the IS space, and regarding BI systems within SAHEIs to be more specific, it is within a practice-based research domain which makes CR an attractive research approach. This is because practice-based research domains encompass aspects of both natural science and social science (Mingers et al., 2013; Volkoff & Strong, 2013; Zachariadis et al., 2013). The choice for CR as the underlying theoretical framework for a mixed methods research of BI within the SAHEIs is strongly supported by previous research (Mingers et al., 2013; Venkatesh et al., 2013; Volkoff & Strong, 2013; Zachariadis et al., 2013). This research on one hand explored the methodological inheritance within the IS domain to reinforce the conventional dichotomies of qualitative and quantitative research methods, and on the other hand inadvertently reinforcing the traditional research approaches with design

science research in information systems. The TAM case study done at Univen, fulfils the interpretive school of thought in IS research, as the researcher attempted to generalize the postulations made within CABIF in a single case study.

At Univen, the researcher leveraged the existing statements of CABIF causal mechanisms, to explain the different core Univen BI events within different contexts and settings. In the ontological analysis of the business intelligence reality space within the SAHEIs, the postulation of an innate level where the BI structures and powers of things may or may not be discernible, was not only a point of theoretical merit, but also has significant methodological connotations. When the researcher pursued CR, the objective was to use the perceptions of empirical BI events to identify the BI mechanisms that resulted in those events. In support of the critical realist view on causality, in the initial phase of the research, the researcher did not look for relationships among distinct BI events. The researcher was actually exploring the processes and conditions under which each BI event causes another.

c) Is the method for data analysis chosen appropriate and aligned to the method chosen?

The critical realist view changes the role of quantitative research methods and techniques, which conventionally measure events as a means of theorizing social laws. They usually achieve this, based on the regularity and the degree of correlation between variables. In this study, the BI structures within the SAHEIs comprised of situated BI interactions which were understood qualitatively, using the CR perspective. The researcher also saw that it was useful to also quantify certain BI characteristics. In that respect, the statistical descriptions obtained through PCA were very helpful simplifications. The PCA served as quantitative BI measures of the number of BI characteristics, which belong to some BI category or a statement about common BI properties or BI features. The BI factor loadings rotation matrix, that was generated through varimax PCA rotation revealed these BI measures.

It is therefore important for this researcher, to show the role played by each type of the research strand in the CR based mixed method research that was undertaken. The quantitative data analysis techniques particularly from PCA, were used to identify relationships and patterns that surfaced from the use of BI within the SAHEIs and to estimate the acceptance of CABIF based BI tools at Univen. The PCA focused strictly

on the identification of observable BI satisfactory and importance factors within the SAHEIs. The identification of observable BI satisfactory and importance regularities, permitted the development of causal statements in support of the argument that, the correlations generated were indeed causations. The correlation values obtained in the correlation matrix violated the stratified ontology principle of CR. However, this researcher argues that it was an escape from the deductive logic used in mainstream research, which according to CR lead to epistemic fallacy. The researcher then used the principles of demi-regularities in the quantitative data analysis techniques, to be in line with the assumptions of critical realist ontology.

Demi-regularities

The BI demi-regularities which according to Lawson (1997), are partial event regularities that indicate the occasional but less universal actualizations of mechanisms or tendencies, over a definite region of time space. This was true in the research because, when the researcher was exploring for BI knowledge to include in CABIF, 15 BI mechanisms were generated, which needed to be subjectively attributed a name. The researcher reaped the rewards by the stance taken, which is of accepting the demi-regularities. Demi-regularities firstly, assisted in focussing on the MM research design, and used PCA to propose BI causal mechanisms within the SAHEIs, and, secondly, the researcher managed to interpret and explain the results of PCA which were fed into DSR. The indicative BI patterns that were scrutinised within the BI factor loadings that resulted from the measured BI variables helped to further the enquiry using qualitative techniques. The researcher is of the view that, the legitimacy of quantitative techniques (PCA) within this study underpinned by CR philosophy, depended more on the interpretation of the statistics, and the processes that were used to validate the research models.

Qualitative Data Analysis

The epistemological validity of the role of qualitative methods or intensive research methods such as interviews, ethnography, case studies, historical narrative etc. within a research study bound by the CR philosophy is quite profound (Mingers et al., 2013; Tashakkori & Creswell, 2008; Tashakkori & Teddlie, 2008). The previous conjecture validates the qualitative techniques used in this study, such as, interviews, document analysis and open-ended questions in the BI survey for SAHEIs. These

qualitative techniques assisted in explaining the BI phenomenon within the SAHEIs, eliciting important reporting elements needed by the institutions, and in generating the CABIF theory. Qualitative techniques helped to build the CABIF, which as a theory assisted in conceptualizing BI objects and structures within SAHEIs at an abstract level. In this study, the role of contextual BI factors within the SAHEIs in BI knowledge generation and their generalization within CR was crucial. The use of content analysis as an empirical qualitative data analysis technique to uncover and distinguish the BI conditions within the SAHEIs was crucial in the development of CABIF.

Role of Critical Realism

The discussion of the roles played by qualitative and quantitative data analysis techniques within the study implies that CR does not entirely commit itself to a single research approach. CR endorses methodological pluralism, where it elicits the use of a variety of quantitative and qualitative research techniques in the same study. The choice of MM research design suffices the ontological and epistemological assumptions of CR, thus the researcher managed to preserve a strong link between meta-theory and the research methods. This study managed to convey the complementarity of the different methods, in addition to distinctly add DSR as an extra research approach within the same enquiry. In this study, the researcher used statistical generalizations produced from quantitative data analysis to make meaningful BI connections with the results of qualitative data analysis. The choice of MM research design is appropriate, as the two research strands show the corroboration/confirmation nature of having qualitative and quantitative approaches in the same study. In a MM approach, it is widely acknowledged to use extensive methods to identify and institute demi-regularities with data patterns, which are then used to direct the extensive research that will expose mechanisms, agencies, and social structures that construct the behaviour observed (Zachariadis et al., 2013). This is actually in line with CR's retroductive approach.

Principle of Retroduction

Retroduction allowed the researcher to move between the knowledge of empirical BI phenomenon within the SAHEIs as expressed through the generated BI events, to the creation of explanations of CABIF, in ways that hold ontological depth and gave some indications on the existence of some unobservable BI entities. The PCA which reduced the observable BI variables from 34 to 15 supports this conjecture. The

subjective names that were given to 15 factors on which the 34 loaded variables loaded on, made the researcher to understand that the SAHEIs BI domain space was different from the way, the researcher thought initially. Under the initial circumstances, the researcher was having inadequate information regarding the BI characteristics within the SAHEIs, until establishing empirical events about the generative BI mechanisms within the institutions. Retroduction allowed the researcher to focus on the research activities and interventions not as discrete events, but as creative processes within the different phases of the MM research. These phases as can be seen, and involved different activities which were sequential and integrated. The researcher made sure that the results of each data analysis phase of the CR based MM research in SAHEIs fed into each other.

d) Has the theory unified various, previously unrelated problems or concepts?

The theory developed through this research is the CABIF. The researcher used CR as the basic philosophical underpinning for this research within the information system domain. In this research, critical realism started from the ontology that identifies BI structures and mechanisms, through which the BI events and discourses were generated. These have been fundamental to the constitution of BI within broader natural and social reality of SAHEIs. The BI reality space within the SAHEIs exist independently of the researcher's beliefs, thoughts, perceptions, and scholarly discourses. The researcher started looking at disparate theoretical and practical foundations of BI within the South African higher education, using the morphogenetic approach. This approach is conceptualised by a cycle constituted by three phases which are: structural conditioning, social interaction, and structural conditioning.

The researcher's view of morphogenesis of BI systems within the SAHEIs indicates that, there are no indications of preferred methodological implementations of BI within the sector. The researcher's attempts to shape and continuously reshape the CABIF by the interplay between structure and agency, are attempts to unify loosely coupled BI entities within the SAHEIs. These attempts to transform the BI domain within SAHEIs, subscribe to Carlsson (2011), who argued that structural conditioning incorporates the critical realist assumption that structure predates actions which transforms it. The structural elaboration or morphogenesis of BI which flows out from the social interactions, where people and BI structures are transformed and structural

reproduction or morphostasis, where people and BI structures are largely reproduced. All the three elements identified in BI are continuous, but the analytical BI components were constituted by breaking up the flows into BI contexts determined by the research problem.

The theories of explanation and design and action were apparent, when the researcher developed the CABIF, as it was principally developed using the scientific nuggets of DSR. Design theory and design knowledge assisted in solving the practical problem of BI within the SAHEIs and achieved the research outcomes. The grounding in previous research and using the prescriptive and descriptive tenets of DSR, the researcher came up with CABIF as the outcome of research. The integration of the extant BI theories, knowledge and data enhanced the conceptualization and substantiation of CABIF.

- e) Has the theory produced new perspectives on existing problems? According to Mavetera (2011) citing Introna (1992), theory should lead to a new understanding of the persisting problems under investigation.**

The CABIF brought into effect the importance of contexts within the BI domain, especially in the SAHEIs. This view can be philosophically categorised as contextualism. In this study, contextualism describes a collection of BI views that emphasized the institutional BI contexts in which an array of tangible actions, scholarly BI utterances, or expressions occurred, and argues that, in some important respect, the BI actions, academic BI utterances, or expressions can only be assumed relative to South African higher education institutional contexts (Dawson & Van Belle, 2013; Lee & Cho, 2013). The fact that SAHEIs have a myriad of heterogeneous characteristics which range from organizational politics and behaviour, institutional business processes, visions and missions, brought forth the need for situated BI systems within the sector. CABIF gave this new perspective, and it put into practice the need to leverage existing IT infrastructures, align IT and business, institute governance principles, and that the road map for BI implementations starts with Basic BI contexts.

This study did not only not address the well-known issues of why organizational information systems persistently fail to provide return on investments, and their adoption or acceptance within the organizations. This study addressed various BI

design, development and implementation issues, and also contributed to the productivity paradox debate within the IS domain. The research touched the conditions on how BI can be conceptualized and become beneficial to the SAHEIs. This research included embedding into the five CABIF contexts institutional capital; ICT complementarities; the commoditization of ICT and a network of BI externalities. Through the retroduction process, the researcher managed to abstract and analyse various BI objects in terms of their constitutive structures and causal powers and came up with the CABIF.

f) Has the theory produced unconventional ideas?

The measurement barometer for minimal creativity in a research should suffice two conditions which are, novelty and agency. The ideas that come out of a research enquiry could be radical and challenging to the existing beliefs in the field of study (Mavetera, 2011). Business Intelligence strategies have been developed used in information systems research, but no one had ever tried to design a contextualised business intelligence framework, that is distinct to a particular business domain. DSR has been used previously as an independent approach to IS research, in this study the researcher included it in a MM research design where qualitative and quantitative approaches are also elicited.

Although this can be referred to as a moderate measure of historical novelty BI frameworks that is judged using “socio-technical facts, not behavioural ones” (Mavetera, 2011). This research not only explored the contextualised nature BI should take within the SAHEIs, it also refutes taking the BI maturity models as the basis for designing, developing and implementing BI within the sector. The researcher has managed to show the significance of the study in developing BI within the SAHEIs, the research gap that exist in using theoretical and practical BI foundations within the sector and this researcher filled this gap by designing CABIF. The aggregation of DSR to qualitative and quantitative methods and showing the value of contextualism for the design, development and implementation of BI within the higher education, portrayed in this thesis, signifies that a moderate degree of creativity was achieved.

g) Is the theory showing positive and negative heuristic power?

The negative heuristic power that can be drawn for this study are as follows:

- i) Scholars have been thorough in researching and documenting business intelligence frameworks suitable for the SAHEIs. The current BI frameworks are sufficient for the sector.
- ii) The current BI frameworks and BI systems are theoretically and practically well understood and are sufficiently meeting the reporting and decision making processes within the SAHEIs.
- iii) The softer aspects of the core institutional systems cannot be captured and aligned with the current BI products.

The positive heuristic powers may be regarded as follows:

- i) There is a huge capacity for improving the designing, development implementation of BI systems by using a contextualised BI framework within the SAHEIs.
- ii) The situated BI epistemologies and ontologies can greatly improve the alignment of core institutional business process, and information technology, improve the decision-making processes and statutory reporting, and finally improve institutional governance and performance.
- iii) Contextualism and the critical realist retroduction approach to the design, development, implementation and review of BI within the SAHEIs is an untapped philosophical approach. There is therefore the need to operationalise these at a more practical level, so as to add value in BI development within the institutions. This also implies that this researcher managed to present an epistemological, ontological, contextualised and critical realist retroductive approach to BI implementation within the SAHEIs.

h) Is there an adequate study of the relevant literature?

It has been difficult for the researcher to judge whether the literature covered in the study was sufficient or not. However, the researcher has gone into covering the history of BI, the BI implementation strategies used in various BI domains, the BI strategies used in the higher education domain, and lastly the research gaps in the design, development and implementation of BI systems within the SAHEIs. Research trends in BI systems tend to emphasize on the use of maturity models, and have been emphasizing on BI technology, rather than situated or contextual institutional aspects especially within the higher education landscape. No one has touched the aspects of governance of higher education institutions, which defines the delegation of authority

mandated to various committees and structures. The governance of institutions has significant impact on the important managerial decisions and institutional contexts which BI can be applied. On that note, the researcher argue that the literature study was sufficient, as it spans the BI implementation strategies in higher education institutions from Africa, Europe, Asia, Australia and the Americas.

7.2.5 Overall Evaluation of the Thesis

The reader may be persuaded through the evaluation presented in this chapter, that there has been undeniably scientific progress in bringing the contextualised nuggets of BI design, development and implementation within the SAHEIs. This study managed to provide guiding principles, a framework per se, that can be used in designing, development and implementation of BI artefacts that are needed to capture and translating human behavioural attributes into BI systems within the SAHEIs. The researcher tried to cover the following questions:

- *What are the conceptual foundations of the business intelligence frameworks currently used in the South African Public Higher Education Institutions?*
- *Are these Business Intelligence technological entities theoretically and practically contextualised?*
- *What Context-aware business intelligence framework is suitable for the South African public Higher Education sector, and why?*
- *How can CABIF be rolled-out as a vehicle for decision making processes at the Univen?*
- *What technology can the Context-Aware business intelligence framework (CABIF) be implemented as a vehicle for decision making processes at the Univen?*

This researcher has heeded to a call for IS practitioners to find more rigorous theoretical foundations upon which they can base their IS development activities. The researcher has noticed that, artefacts are built from the behavioural and technical aspects of organizations, which can reveal the essence of social constructivism within the IS domain. This researcher's attempts to show multiplicity in IS research methods in the same enquiry, heeded to the recent calls in IS domain. There are still many questions that need to be explored, and one such aspect is the replicability of the study to span the whole array of SAHEIs. The other question that needs to be addressed is the acceptability of CABIF to the wider scholars of BI systems.

7.3 Problems that arose during the Research

A couple of problems came up during the data collection phase. One of the challenges was the lengthy period taken to obtain ethical clearances from the various SAHEIs. Each institution has its own ethical clearance policy, and procedures to follow especially for external researchers. The researcher abandoned the use of face-to-face interviews during the research, because of the geographical distances that existed between this researcher and most of the institutions. This led to the data collection through online surveys and telephonic interviews. Some institutions gave gatekeeping ethical clearances, and there was only limited evidence for the performance of a gatekeeping role by research officials in the institutions that gave these. The researcher had to tirelessly follow-up by a series of telephone calls, to get them to put the intended survey respondents on board. This was a great frustration, because it removed the likelihood of having a considerable number of respondents as this would even have direct impact on the quantitative data analysis.

A second problem was the adherence of the circumstances specified by the Univen Research Ethics Committee by some members of the Univen management staff. It took this researcher several months to be given access to the Univen MIS system and get the databases, as conflicting views came up as results of the researcher's access to the data. It is evident that; the researcher was unable to avoid getting access to personal information about students and staff and even institutional financial information. The decision was made to use a dummy university but it was not practical, and not ethically sound from a research point of view. The researcher later gained access to the Univen MIS system in January 2016, after the intervention of the two Deputy Vice-Chancellors and the doctoral research Promoter.

The third problem concerned the access to the Univen system which could not be accessed remotely. The researcher had to be on Univen campus in order to get access to the system, and in many occasions the access to the system was constantly suspended. Even though through the researcher managed to secure two HEDA application for free use at Univen, the PowerHEDA administrator was constantly suspending the user account. There was no respect at all for the Ethical Clearance Certificate awarded by the institution. The researcher resorted to constantly register in the system, and the ICT services assisted me in getting into the backend of the system. This researcher sincerely appreciated their efforts in giving access to the ITS schemas and tables, and ultimately the researcher managed to create the

linked server without any problems. The only problem was the Univen domain password which according to policy was supposed to be reset after a month in use.

7.4 Limitations of the Study

The research involved a thorough in-depth study of the various business intelligence implementation strategies or frameworks based on previous research, and proposing one suitable for the South African higher education sector. The research design in this case the mixed methods research involved multiple research methods, it has been a challenge on its own as each method has its own paradigmatic epistemologies and ontologies. The scarcity of the literature review that looked at various business intelligence initiatives and implementation frameworks in the higher education sector, in order to benchmark how these university-wide management information systems are being used for decision support activities, was a challenge. There was also a limitation in comparing BI literature with that of the SA higher education which has limited literature on BI implementations.

Although the principal components analysis of the BI data set from the South African higher education sector assisted in developing, a context-aware business intelligence framework it was a challenge to map the results using design science research. The researcher developed the CABIF to support various institutional processes that included performance management and measurement, decision making activities, policy formulation, and quality assurance and profiling student, staff, and space data, but the BI roadmap is circumstantial than being a standard BI roadmap. If CABIF based university-wide business intelligence application is implemented, it will allow the SAHEIs to monitor their performance, but achieving universal acceptance might be a limitation.

The development and deployment of a new business intelligence framework, in this case, a context-aware business framework, is a challenging task. The accessibility of such a framework within the academic community can be difficult. As a result of budgetary constraints and funding, the developed framework was deployed, tested, and evaluated at one university, which is the University of Venda. It could have been more significant if the framework, including the technology platform chosen were tested and deployed in a number of South African universities. In this way, the effectiveness of the framework and technologies could be more representative within the South African higher education institutions. Sample size is a measure of the significance of the research, the researcher would otherwise have wanted to have a compliment of respondents from all the 26 public

universities and implement the CABIF based BI system to at least 13 institutions. However, because of geographical dispersion, and funding constraints the deployment of CABIF was limited to Univen.

7.5 Future Directions of the Study

The maturity models, have become an established means in the IS community to support organizations when it comes to effective management and continuous improvement for complex, multi-faceted phenomena. In this research, the researcher explored a context-aware approach in developing a BI framework that takes five contexts into account. This approach contrasts the “*one size fits all*” approach of the existing BI frameworks specifically in higher education. Five BI contexts, were derived using a quantitative approach based on predetermined BI latent variables and observable variables. The results of principal components analysis which constituted the quantitative research were coupled with design science research to come up with CABIF for the South African higher education.

The five different contexts in the CABIF, might result into divergent BI implementation paths within the South African higher education institutions, thus the need for a well-researched and designed BI roadmap for the sector. The future work for this study, might be addressing the need for a further research on the BI roadmap, by further cluster analysis of the BI observable characteristics. The quantitative analysis might nonetheless go beyond the PCA and be conducted using structured equation modelling to further reveal the most important BI factors. Moreover, the impact of the resultant BI contextual components on institutional BI implementations should be addressed in depth in the future research. The expansion of the typology of each generated BI context should be a prerogative of the future research. This would further decompose the CABIF contexts, to take into account the situational analysis and contexts of each higher education institution in SA.

The future research includes revamping the data architecture of the proposed solution. The researcher has catered for structured data structures, but with the advent of unstructured data sources and big data, it means that future research should address these challenges. Typically, the researcher addressed the data assets lying in the ERP system, HEMIS data and Spreadsheets, but has not included data assets from the Learning Management Systems; Research Information Management Systems; Library Information Systems and other peripheral systems within the institutions. This entails that data integration and reporting from various peripheral systems and of different structure should be addressed in

future research. In the TAM study at Univen the job profiles of the respondents might be an additional external variable, which might be incorporated in the future.

7.6 Recommendations

The reality is that the SAHEIs' dependence on data is rising exponentially. With more demand on compliance and accountability from statutory bodies, SAHEIs virtually require the application of data analytics or BI to extract meaning and subsequent action. The triad of technologies associated with data discovery tools, mobile devices, and self-service BI considerably augments the movement towards the simplification of BI. This requires institutions to have conceptual, methodological and practical approaches to the implementation of BI systems.

The researcher recommends institutions to implement a BI system with data discovery and with the capability of lessening the need for conventionally lengthy (and time-consuming) BI reports. These data discovery tools are supposed to be augmented by dashboards and interactive visualization tools. These ensure users to easily discern trends in the data, data smash-ups and in-memory analytics enable users to quickly query a variety of siloed data sources. The BI systems should not rely on one technology platform, considering the exponential use of mobile technologies, the BI reports should render in any technology platform.

The users will use the BI systems if they are adequately trained and well-informed of the benefits of BI. Training the users exhaustively, will make the BI system receive greater acceptance and adoption within the institution. Thus, the researcher recommends to empower users within the institution, by giving them access to the skills required to manipulate the BI tools on their own. The researcher also recommends the restructuring of IT departments within the institutions so that they are more aligned with the core institutional business processes. This would produce the much-needed business value via analytics and BI.

Self-service BI should not be an excuse within the SAHEIs. Judging by the deficiency in the triad of BI skills set, automation tools with script less and self-service capabilities can greatly increase the rate at which end users can derive insights from BI on their own. The other factor is that consumerization of IT is largely facilitated by the ease of use and convenience of data discovery. When users are offered greater autonomy and flexibility to manipulate BI applications and tools they would simply adopt the system. Last but not the least, BI systems

are not supposed to be implemented in an ad-hoc way, build and fix, or in a haphazard manner. BI systems are supposed to be designed, developed and implemented using certain epistemological and methodological frameworks. This researcher therefore recommends that South African higher education institutions to try to use CABIF, the related worksheets of CABIF and the BI implementation roadmap. This is a BI framework developed using informed IS research methods and has been practically implemented at Univen.

7.7 Autobiographical Reflections

The researcher had an invaluable learning experience by embarking on this research study. The researcher has considerably increased the understanding of the complexities of the nature of research and the difficulty in separating this research from others. The researcher has learned, for example, that BI characteristics do not cluster neatly into predefined clusters and that research can be frustrating and sometimes tedious, yet at other times immensely rewarding and even exhilarating. With this research study, this researcher has provided some key ideas which will help institutions to examine their BI initiatives. The researcher provided the context-aware BI framework for the SAHEIs, which incorporate the SA higher education legislative framework and core institutional business processes. The researcher has grown an awareness of the importance of the alignment of IT and core institutional business process. This researcher has also begun to question how the SAHEIs structure their BI teams and how they design, develop and implement BI systems within their institution.

The undertaking of this research, has also encouraged the researcher to review the BI contexts within the wider South African higher educational field. This research has provided the researcher with a wealth of BI intelligence resources, which will definitely have an impact on how BI systems are designed, developed and implemented in the SA higher education. The theoretical, and practical foundations of implementing BI system in SAHEIs, using a context-aware BI framework is both academically sound and appealing. This research qualifies into the software engineering methodologies, but within a specific niche, which is the South African higher education. This research addresses the quest for data scientists within South African higher education, and can be easily adopted within the African higher education landscape. In summary, this researcher had experienced the practical complexities and methodological glitches of carrying out a doctoral research. This required perseverance, dedication and compromising some proposed activities and methodological approaches.

7.8 Concluding Remarks

The researcher chose the design science research (DSR) approach for the conceptualization of the CABIF based on Hevner & Chatterjee (2010), who cited it as a pragmatic research paradigm suitable for the creation of innovative IS artefacts. This researcher concurs with many IS researchers in that, business intelligence systems are developed and implemented in any institution to enhance its operational, tactical and strategic efficiency and effectiveness. In the development of the CABIF, the researcher embraced the fact that the usefulness of the BI systems within the institutions takes various elements, which are summarised as **contexts**. The BI practitioners and higher education managers should be aware and responsive to these BI contexts, which have direct impact on the core institutional business processes. In this research, the researcher argues that the institutional characteristics, its people, its processes, technologies and methodologies for developing and implementing BI systems are paramount in developing a BI framework, and should be linked to the core institutional lines of business. The varied taxonomy of knowledge gathered from the SA higher education sector, was vital in bringing forth the theoretical and practical foundations of the CABIF.

References

- Acebo, A., Franks, B., Leonard, T., Manthey, K., & Burgess, M. (2012). BI Experts' Perspective: Attracting Analytics Talent. *Business Intelligence Journal*, 17(3), 21-27.
- Akbay, S., Fryman, H., Stodder, D., & Taylor, J. (2011). Moving to Real-Time BI. *Business Intelligence Journal*, 16(4), 19-26.
- Allen, D. K., Brown, A., Karanasios, S., & Norman, A. (2013). How Should Technology-Mediated Organizational Change Be Explained? A Comparison of Critical Realism and Activity Theory. *MIS Quarterly*, 37(3), 835-854.
- Anagnostopoulos, C., & Hadjiefthymiades, S. (2010). Advanced fuzzy inference engines in situation aware computing. *Fuzzy Sets and Systems*, 161(2010), 498–521.
- Anagnostopoulos, C., & Hadjiefthymiades, S. (2013). Multivariate context collection in mobile sensor networks. *Computer Networks*, 57(2013), 1394–1407.
- Angen, M. J. (2000). Evaluating interpretive inquiry: Reviewing the validity debate and opening the dialogue. *Qualitative Health Research*, 10(3), 378-395.
- Asmal, K. (2003a). *Government Gazette: Higher Education Act, 1997 (ACT No. 101 of 1997), Funding of Public Higher Education*. Pretoria: Department of Education.
- Asmal, K. (2003b). *Policy and Procedures for Measurement of Research Output of Public Higher Education Institutions*. Pretoria: DoE.
- Ayyagari, R., Grover, V., & Purvis, R. (2011). Technostress: Technological Antecedents and Implications. *MIS Quarterly*, 35(4), 831-858.
- Azmaa, F., & Mostafapourb, M. A. (2012). Business intelligence as a key strategy for development organizations. *Procedia Technology*, 1(2012), 102 -106.
- Bahrami, M., Arabzad, M. S., & Ghorbani, M. (2012). Innovation In Market Management By Utilizing Business Intelligence: Introducing Proposed Framework. *Procedia Social and Behavioural Science*, 41(2012), 160 -167.
- Barbosa, J., Dillenburg, F., Lermen, G., Garzão, A., Costa, C., & Rosa, J. (2012). Towards a programming model for context-aware applications. *Computer Languages, Systems & Structures*, 38(2012), 199–213.
- Barnes, S., Ring, T., Yamunan, V., Franks, B., Hiltbrand, T., Taylor, J., & Williams, S. (2012). Requirements for Predictive Analytics. *Business Intelligence Journal*, 17(1), 20-27.
- Beaumont, R. (2012, 23/04/2012). An introduction to Principal Component Analysis & Factor Analysis Using SPSS 19 and R (psych package). *Statistics 2*. Retrieved from <http://www.floppybunny.org/robin/web/virtualclassroom/stats/statistics2/pca1.pdf>. [Accessed on 25 May 2015]
- Beckett, T., & McComb, B. E. (2012) Increase Enrollment, Retention and Student Success: Best Practices for Information Delivery and Strategic Alignment. (pp. 1-34). New York: Information Builders.

- Berg, B. C. (2007). *Qualitative research methods for the social sciences* (6th ed.). Boston, MA: Pearson Education Inc.
- Briggs, L. (2011). BI Case Study: Apparel Company App Melds Fashion, Mobile BI. *Business Intelligence Journal*, 16(4), 39-41.
- Briggs, L. (2012). Cloud-Based Software Makes Environmental Data More Accessible. *Business Intelligence Journal*, 17(3), 18 - 20.
- Briggs, L. (2014). BI Case Study: Stanford Graduate School of Business Builds Operational BI for Data in the Cloud. *Business Intelligence Journal*, 19(1), 36-38.
- Bryman, A. (2004). *Social Research Methods* (Second ed.). Oxford: Oxford University Press.
- Burke, M., & Hiltbrand, T. (2011). How Gamification Will Change Business Intelligence. *Business Intelligence Journal*, 16(2), 8-16.
- Burton, B. (2007). *Toolkit: Maturity Checklist for Business Intelligence and Performance Management*. (G00148319). Stamford.
- Cantin, M. (2011). Making Your Organization Care about Data Quality. *Business Intelligence Journal*, 16(4), 43-52.
- Carlsson, S. A. (2011). Critical Realist Information Systems Research in Action. In M. C. e. al. (Ed.), *Future IS 2011, IFIP AICT* (pp. 269-284). IFIP International Federation for Information Processing 2011: IFIP.
- Chandler, N., Hostmann, B., Rayner, N., & Herschel, G. (2011). *Gartner's Business Analytics Framework*. (G00219420). Stamford,.
- Che. (2000). *Towards a new Higher Education Landscape: Meeting the Equity, Quality and Social Imperatives of South Africa in the 21ST Century*. Pretoria: CHE.
- Che. (2012). *VitalStats Public Higher Education 2010*. Pretoria: Council on Higher Education.
- Che. (2013). *A Framework for Qualification Standards in Higher Education*. Pretoria: CHE.
- Che. (2014). *Quality Enhancement Project: The Process for Public Higher Education Institutions*. Pretoria: CHE.
- Chen, H., Chiang, R. H. L., & Storey, V. C. (2012). Business Intelligence and Analytics: From Big Data to Big Impact. *MIS Quarterly*, 36(4), 1-24.
- Chen, Y., & Hu, H. (2013). Internet of intelligent things and robot as a service. *Simulation Modelling Practice and Theory*, 34(2013), 159-171.
- Couture, N. (2012). Reducing Data Management Complexity in the Enterprise. *Business Intelligence Journal*, 17(1), 31-37.
- Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), 319-340.
- Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer-Technology: A Comparison of Two Theoretical Models. *Management Science*, 35(8), 982-1003.
- Davis, G. B., & Olson, M. H. (1985). *Management Information Systems: Conceptual Foundations, Structure and Developments* (2nd ed.). New York: McGraw-Hill.

- Dawson, L., & Van Belle, J.-P. (2013). Critical success factors for business intelligence in the South African financial services sector. *SA Journal of Information Management*, 15(1), 1-12.
- De Villiers, R. M. (2012). Models for Interpretive Information Systems Research, Part 1: IS Research, Action Research, Grounded Theory – A Meta-Study and Examples. In M. Mora, O. Gelman, A. Steenkamp, and M. S. Raisinghani (Eds.), *Research Methodologies, Innovations and Philosophies in Software Systems Engineering and Information Systems* (pp. 222-237). USA: Information Science Reference.
- Decouchant, D., Mendoza, S., Sánchez, G., & Rodríguez, J. (2013). Adapting groupware systems to changes in the collaborator's context of use. *Expert Systems with Applications*, 40(2013), 4446 – 4462.
- Deng, R. (2007). Business Intelligence Maturity Hierarchy: A New Perspective from Knowledge Management. Retrieved from <http://www.information-management.com/infodirect/20070323/1079089-1.html>. [Accessed on 25 June 2015]
- Devlin, B. (2012). Collaborative Business Intelligence: Socializing Team-Based Decision Making. *Business Intelligence Journal*, 17(3), 9 - 17.
- Dhet. (2012). *Policy and Procedures for Measurement of Research Output of Public Higher Education Institutions*. Pretoria: Ministry of Education.
- Dhet. (2013). *White Paper for Post-School Education and Training: Building an Expanded, Effective and Integrated Post-School System*. Pretoria.
- Dhet. (2014a). *Guidelines for Clinical Training Plans and Budgets: 2014/15 & 2015/16*. Pretoria: DHET.
- Dhet. (2014b). *Ministerial Statement on Enrolment Planning 2014/15 - 2019/20 for Universities*. Pretoria: DHET.
- Dhet. (2014c). *Policy Framework on Differentiation in the South African Post-School System*. Pretoria: DHET.
- Doe. (1997). *Education White Paper 3: A Programme for the Transformation for Higher Education*. Pretoria: Department of Education.
- Doe. (2001). *National Plan for Higher Education*. Pretoria: Tirisano.
- Doe. (2004). *A New Funding Framework: How Government Grants are Allocated to Public Higher Education Institutions*. Pretoria: Department of Higher Education and Training.
- Doe. (2011). *Ministerial Statement on Enrolment Planning 2011/12 - 2013/14*. Pretoria: DoE.
- Dpsa. (2014). *Implementation Guideline for Corporate Governance of Information and Communication Technology Policy Framework Version 2*. Pretoria: DPSA Retrieved from <http://www.gov.za/sites/www.gov.za/files/CGICTPolicyFramework.pdf>.
- Dresner, H. (2011). Mobile Business Intelligence Market Study. Retrieved from <http://howarddresner.com/>. [Accessed on 25 May 2016]
- Eckerson, W. (2004). Gauge Your Data Warehouse Maturity. *DM Review*, 14(11), 34-38.

- Eckerson, W. (2012). TDWI Benchmark Guide: Interpreting Benchmark Scores Using TDWI's Maturity Model. Retrieved from <http://tdwi.org/whitepapers/2014/10/tdwi-analytics-maturity-model-guide.aspx>. [Accessed on 23 June]
- Educause. (2014). About EDUCAUSE. Retrieved from <http://www.educause.edu/>. [Accessed on 07 July 2015]
- Ehrenmann, M., Pieringer, R., & Stockinger, K. (2012). Is There a Cure-All for Business Analytics? *Business Intelligence Journal*, 17(3), 28-39.
- Falamasir, M. H., Moaven, S., Abolhassani, H., & Habibi, J. (2010, 23-25 June 2010). *Business Intelligence in Elearning (Case Study on the Iran University of Science and Technology DataSet)*. Paper presented at the International Conference on Software Engineering and Data Mining, Chengdu.
- Faulkner, P., & Runde, J. (2013). TECHNOLOGICAL OBJECTS, SOCIAL POSITIONS, AND THE TRANSFORMATIONAL MODEL OF SOCIAL ACTIVITY. *MIS Quarterly*, 37(3), 803-818.
- Fedouaki, F., Okar, C., & El Alami, S. (2013). A maturity model for Business Intelligence System project in Small and Medium-sized Enterprises: an empirical investigation. *IJCSI International Journal of Computer Science Issues*, 10(6), 61 -69.
- Fehlberg, F. W., Rolim, C. O., Leithardt, V. R. Q., Geyer, C. F. R., & Silva, L. C. (2013). MultiS: A Context-Server for Pervasive Computing. *Electronic Notes in Theoretical Computer Science*, 292(2013), 39 - 56.
- Fenn, J. (2007, July 2013). Understanding Gartner's Hype Cycles, 2007 Retrieved from <http://www.gartner.com/DisplayDocument?id=509085>. [Accessed on 15 April 2016]
- Fish, O. (2014). A Practical Approach to Business Intelligence in Higher Education. *Business Intelligence in Higher Education - Nacubo*. Retrieved from www.nacubo.org/.../Practical%20Approach%20Nacubo%202014%20v2.pdf. [Accessed on 07 July 2015]
- Foody, P. (2009). User-Centred Business Intelligence. *Business Intelligence Journal*, 14(4), 17-25.
- Gartner. (2014). Business Intelligence - BI - Gartner. Retrieved from <http://www.gartner.com/it-glossary/business-intelligence-bi/>. [Accessed on 15 July 2015]
- Geerts, G. L. (2011). A design science research methodology and its application to accounting information systems research. *International Journal of Accounting Information Systems*, 12(2011), 142-151.
- Geiger, J. G., Rahman, A., & Barth, B. (2008). Reuse It or Lose It: Achieving Business Intelligence Efficiency. *Business Intelligence Journal*, 13(1), 7-12.
- Goes, P. B. (2013). Information Systems Research and Behavioural Economics. *MIS Quarterly*, 37(3), iii-viii.
- Goes, P. B. (2014). Design Science Research in Top Information Systems Journals. *MIS Quarterly*, 38(1), iii-viii.

- Gonzales, M. L. (2011). Success Factors for Business Intelligence and Data Warehousing Maturity and Competitive Advantage. *Business Intelligence Journal*, 16(1), 22-29.
- Gregor, S. (2006). The Nature of Theory in Information Systems. *MIS Quarterly*, 30(3), 611–642.
- Gregor, S., & Hevner, A. R. (2013). Positioning and Presenting Design Science Research for Maximum impact. *MIS Quarterly*, 37(2), 337-355.
- Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. Denzin and Y. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 105-117). New York, USA: SAGE Publications, Inc.
- Guillemette, M. G., & Paré, G. (2012). Toward a New Theory of the Contribution of the IT Function in Organizations. *MIS Quarterly*, 36(2), 529-551.
- Guster, D., & Brown, C. G. (2012). The Application of Business Intelligence Higher Education: Technical and Managerial Perspectives. *Journal of Information Technology*, XXIII(2), 42-62.
- Habib, A. (2016). Reimagining the South African university and critically analysing the struggle for its realisation. Retrieved from <https://www.wits.ac.za/news/latest-news/in-their-own-words/2016/2016-01/reimagining-the-south-african-university-and-critically-analysing-the-struggle-for-its-realisation.html>. [Accessed on 24 May 2016]
- Hagert, J. (2006). *AMR Research's Business Intelligence/Performance Management Maturity Model, Version 2*. (G00183058). Stamford.
- Halper, F., & Krishnan, K. (2014). *TDWI Big Data Maturity Model Guide: Interpreting Your Assessment Score*. Stamford.
- Halper, F., & Stodder, D. (2015, 15 June 2015). *TDWI Analytics Maturity Model Guide*. Research Paper. TDWI Research: TDWI Benchmark Guide, (2014-2015). Renton.
- Handoyoa, E., Isnanto, R. R., & Sonda, M. A. (2012). SRS Document Proposal Analysis on the Design of Management Information Systems According to IEEE STD 830-1998. *Procedia - Social and Behavioral Sciences*, 67 (2012), 123 – 134.
- Hatta, N. N. M., Miskon, S., Ali, N. M., Abdullah, N. S., Ahmad, N., Hashim, H., . . . Maarof, M. A. (2015). Business Intelligence System Adoption Theories in SMEs: A Literature Review. *ARPJ Journal of Engineering and Applied Sciences*, 10(23), 18165 - 18174.
- Henry, H., & Hiltbrand, T. (2012). The 2020 Workplace and the Evolution of Business Intelligence. *Business Intelligence Journal*, 17(13-19).
- Hess, T. J., McNab, A. L., & Basoglu, K. A. (2014). Reliability Generalization of Perceived Ease of Use, Perceived Usefulness, and Behavioral Intentions. *MIS Quarterly*, 38(1), 1-28.
- Hevner, A., & Chatterjee, S. (2010). Design Research in Information Systems: Theory and Practice. In A. Hevner and S. Chatterjee (Eds.), *Integrated Series in Information Systems* (Vol. 22, pp. 320). London: Springer.
- Hevner, R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, 28(1), 75-105.

- Hiltbrand, T. (2010). Social Intelligence: The Next Generation of Business Intelligence. *Business Intelligence Journal*, 15(3), 7 - 13.
- Hseih, H. F., & Shannon, S. E. (2005). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*, 15(9), 1277-1288.
- Ibm. (2010). *Managing the business of higher education: Analytics for better results*. IBM Software, Business Analytics Education Cognos Software. Ottawa, ON, Canada.
- Imhoff, C., & White, C. (2010). Business Intelligence and Collaboration: A Natural Marriage. *Business Intelligence Journal*, 15(3), 44 - 48.
- Introna, D. (1992). *Towards a theory of management information*. Pretoria: University of Pretoria (Unpublished DCom Dissertation).
- Javadi, M. H. M., & Dastjerdia, M. D. (2011). Evaluation effect of management information system implementation on personnel resistance causes in Isfahan power plant management corporation in Iran. *Procedia Computer Science*, 3 (2011), 1296–1303.
- Jennings, C., & Lewis, T. (2011). The Perils of Over-Complicating Data Warehouses: How Avoiding Unnecessary Complexity Can Provide Satisfaction and Savings. *Business Intelligence Journal*, 16(2), 39-43.
- Jisc. (2014). Business Intelligence. Retrieved from <http://www.jiscinfonet.ac.uk/whole-infokit/?infokit=233>. [Accessed on 06 July]
- Kleesuwana, S., Mitathab, S., Yupapinc, P. P., & Piyatamrong, B. (2010). Business Intelligence in Thailand's Higher Educational Resources Management. *Procedia Social and Behavioral Sciences*, 2(2010), 84-87.
- Kroonenberg, P. M. (2008). *Applied Multiway Data Analysis*. Wiley Series in Probability and Statistics John Wiley & Sons.
- Lahl, D. (2011). Make Better Decisions by Analyzing Structured and Unstructured Data Together. *Business Intelligence Journal*, 16(1), 9-16.
- Lahrmann, G., Marx, F., Winter, R., & Wortmann, F. (2011). *Business Intelligence Maturity: Development and Evaluation of a Theoretical Model*. Paper presented at the 44th Hawaii International Conference on System Sciences, Hawaii.
- Lee, Y. S., & Cho, S., B. (2013). Mobile context inference using two-layered Bayesian networks for smartphones. *Expert Systems with Applications*, 40(2013), 4333 – 4345.
- Lewis, K. (2013). Four Lessons Learned Building a Data Warehouse in the Real World. *Business Intelligence Journal*, 18(1), 8-12.
- Lock, M. (2011). *Business Intelligence on TCO Diet: Slashing the Cost of Insight with Analytical Fitness*. Retrieved from Aberdeen:
- Luftman, J. N., & Derksen, B. (2012). Key Issues for IT Executives 2012: Doing More with Less. *MIS Quarterly Executive*, 11(4), 203-213.
- Luhn, H. P. (1958). A Business Intelligence System. *IBM Journal*, October(1958), 314-319.

- Mabizela, S. (2015). Higher Education for a Higher Purpose: Rising to the Challenge. Retrieved from <https://www.ru.ac.za/media/rhodesuniversity/content/vc/documents/Dr%20Mabizela%20Inaugural%20address.docx>. [Accessed on 24 May 2016]
- Mackenzie, S. B., Podsakoff, P. M., & Podsakoff, N. P. (2011). Construct Measurement and Validation Procedures in MIS and Behavioural Research: Integrating New and Existing Techniques. *MIS Quarterly*, 35(2), 293-334.
- Manuel, T. A., & Ramaphosa, C. (2011). *National Development Plan: Vision for 2030*. Pretoria: National Planning Commission.
- Mavetera, N. (2011). *Towards an ontology-driven software development approach: An unended quest*. (Doctor of Philosophy), University of Pretoria, Pretoria.
- Mckenna, J. P. (2011). Moving Toward Real-Time Data Warehousing. *Business Intelligence Journal*, 16(16), 3.
- Mingers, J., Mutch, A., & Wilcocks, L. (2013). Critical Realism in Information Systems Research. *MIS Quarterly*, 37(3), 795-802.
- Moody, D., Jacob, M. E., & Amrit, C. (2010). *In Search of Paradigms: Identifying the Theoretical foundations of the IS Field*. Paper presented at the The European Conference on Information Systems, Pretoria, South Africa.
- Mosia, N. T. (2014). *Government Gazette, NATIONAL QUALIFICATIONS ACT, 2008 (ACT NO. 67 OF 2008): HIGHER EDUCATION QUALIFICATIONS SUB-FRAMEWORK (HEQSF)*. Pretoria: CHE.
- Muriithi, G. M., & Kotzé, J. E. (2013). *A Conceptual Framework for Delivering Cost Effective Business Intelligence Solutions as a Service*. Paper presented at the SAICSIT '13,, East London, South Africa.
- Musumba, G. W., & Nyongesa, H. O. (2013). Context Awareness in Mobile Computing: A Review. *ijmla*, 2(1), 1-10.
- Mutanga, A. (2013). *Mental Models of Robotic Programming Using Cognitive Apprenticeship*. Germany: LAP LAMBERT Academic Publishing.
- Mutanga, A. (2015). A Context-Based Business Intelligence Solution for South African Higher Education. *Journal of Industrial and Intelligent Information*, 3(2), 119-125.
- Myers, M. D., & Venable, J. R. (2014). A set of ethical principles for design science research in information systems. *Information & Management*, 51(2014), 801-809.
- Negash, S., & Gray, P. (2008). Business Intelligence. In F. Burstein, Holsapple, W., and Clyde, W. (Ed.), *Handbook on Decision Support Systems* (pp. 175-193): Springer.
- Nudurupati, S. S., Bititci, U. S., Kumar, V., & Chan, F. T. S. (2011). State of the art literature review on performance measurement. *Computers & Industrial Engineering*, 60 (2011), 279–290.
- Nzimande, B. E. (2012). *South African Education Information Standards: Data Quality Standard for Surveys*. Pretoria: Government Printers.

- Nzimande, B. E. (2014a). *Higher Education Act, 1997 (ACT NO. 101 of 1997) Section 41 read with Section 69: Regulations for Reporting by Public Higher Education Institutions*. Pretoria: Higher Education and Training.
- Nzimande, B. E. (2014b). *Ministerial Statement on University Funding: 2015/16 and 2016/17*. Pretoria: Higher Education and Training.
- Nzimande, B. E., & Metcalfe, M. (2010). *Department of Higher Education & Training : Strategic Plan 2010 - 2015*. Pretoria: DHET.
- O'leary, D. E. (2009). The Impact of Gartner's Maturity Curve, Adoption Curve, Strategic Technologies on Information Systems Research, with Applications to Artificial Intelligence, ERP, BPM, and RFID. *Journal of Emerging Technologies in Accounting*, 6(2009), 1-22.
- Ocu. (2013). Maturity Model for Institutional Intelligence v1.0: White Book of Institutional Intelligence in Universities. Retrieved from www.jisc.ac.uk/sites/default/files/wbi2_-_maturity_model_final_1.0.pdf. [Accessed on 06 July 2015]
- Orr, J. C. (2011). *Data Governance for the Executive* (M. W. Orr and K. Vivian Eds.). Colorado, USA: Sena Publishing, LCC.
- Parenteau, J., Chandler, N., Sallam, R. L., Laney, D., & Duncan, A. D. (2014, 21 November 2014). Predicts 2015: Power Shift in Business Intelligence and Analytics Will Fuel Disruption. *Gartner Technology*. G00270932. Retrieved from <http://www.gartner.com/technology/reprints.do?id=1-26A47QE&ct=14121&st=sb>. [Accessed on 27 February 2016]
- Piedade, M. B., & Santos, Y. M. (2010). *Business Intelligence in Higher Education: Enhancing the Teaching and Learning process with a SRM Sytem*. Paper presented at the 5th Iberian Conference on Information Systems and Technologies, Santiago de Compostela.
- Polites, G., & Watson, R. T. (2009). Using Social Network Analysis to Analyze Relationships among IS Journals. *Journal of AIS*, 10(Article 8), 595.
- Porter, E. C., & Donthu, N. (2006). Using the Technology Acceptance Model to Explain how Attitudes Determine Internet Usage: The Role of Perceived Access Barriers and Demographics. *Journal of Business Research*, 59(2006), 999-1007.
- Presidency. (1997). *Higher Education Act 101 of 1997, as amended 1999 to 2012*. Pretoria: Presidency.
- Presidency. (2009). *Government Gazette No. 67, 2008 : National Qualifications Framework Act*. Pretoria: Presidency.
- Rajterič, I. H. (2010). Overview of Business Intelligence Maturity Models. *Management*, 15(1), 47-67.
- Rayner, N., & Schlegel, K. (2008). *Maturity Model Overview for Business Intelligence and Performance Management*. (G00164094). Stamford.
- Reiser, A., & Wende, J. (2014). A new paradigm of Business Intelligence: How in-memory computing can change the analytical landscape. *Performance*, 6(2), 30-35.

- Russom, P. (2010). Operational Data Integration. *Business Intelligence Journal*, 14(2), 61-62.
- Russom, P. (2012). Analytic Database Systems. *Business Intelligence Journal*, 17(3), 56.
- Rutstein, J. (2011). Is It Really “Bad” Data? An Argument for Usable Business Metadata. *Business Intelligence Journal*, 16(3), 7-13.
- Sandler, D. (2010). Best Practices for Applying Agile Techniques to Data Warehouses. *Business Intelligence Journal*, 15(4), 17-27.
- Sap. (2015). SAP® BusinessObjects™ Business Intelligence Solutions: Comparison of Features by Version for the SAP BusinessObjects BI Platform. In S. SE (Ed.), (pp. 48): SAP SE.
- Sarker, S., Xiao, X., & Bealieu, T. (2013). Qualitative Studies in Information Systems: A Critical Review and Some Guiding Principles. *MIS Quarterly*, 37(4), iii-xviii.
- Scott, K. L. (2011). Five Emerging Web Standards and Their Promise for Business Intelligence Applications. *Business Intelligence Journal*, 16(17-21).
- Sen, A., & Sinha, S. P. (2005). A Comparison of Data Warehousing Methodologies. *Communications of the ACM*, 48(3), 79-84.
- Shankar, R. (2011). Harnessing the Power of Social Media Data with Master Data Management. *Business Intelligence Journal*, 16(4), 27-33.
- Shankar, R., & Menon, R. (2010). MDM Maturity: Pragmatism, Business Challenges, and the Future of MDM. *Business Intelligence Journal*, 15(3), 19 - 25.
- Sharma, K. S., & Chandel, K. J. (2013). Technology Acceptance Model for the Use of Learning Through Websites Among Students. *International Arab Journal of e-Technology*, 3(1), 44-49.
- Sharman, D. (2010). An Introduction to Business Intelligence for Higher Education, 1-7. Retrieved from 15 June 2016 www.collegiateproject.com website: <http://www.collegiateproject.com/articles/An%20Introduction%20to%20Business%20Intelligence.pdf> [15 June 2016]
- Sherman, R. (2015). *Business Intelligence Guidebook From Data Integration to Analytics* (S. Elliot Ed. 1 ed.). Waltham, USA: Morgan Kaufmann : Elsevier.
- Singh, R. J. (2015). Current Trends and Challenges in South African Higher Education. *South African Journal of Higher Education*, 29(3), 1-7.
- Skene, J., & Bunting, I. (2009). *Space and Cost Norms for Buildings and Other Land Improvements at Higher Education Institutions*. Pretoria: Department of Higher Education and Training.
- Skene, J., Bunting, I., De Beer, H., & Belding, L. (2009). *CESM: Classification of Educational Subject Matter*. Pretoria: Department of Education.
- Skene, J., Bunting, I., Mokotedi, D., Steyn, G., & Stoop, L. (2009). *Building and Space Inventory and Classification Manual*. Pretoria: Department of Higher Education.
- Smith, H. A., Watson, R. T., & Sullivan, P. (2012). Delivering an Effective Enterprise Architecture at Chubb Insurance. *MIS Quarterly*, 11(2), 75-85.
- Steyn, A. G. W., & De Villiers, A. P. (2011). *Public Funding of Higher Education in South Africa by Means of Formulae*. Pretoria: CHE.

- Stieglitz, S., & Brockman, T. (2012). Increasing Organizational Performance by Transforming into a Mobile Enterprise. *MIS Quarterly*, 11(4), 189-204.
- Stoodley, N. (2012). Democratic Analytics: A Campaign to Bring Business Intelligence to the People. *Business Intelligence Journal*, 17(1), 7-12.
- Straub, D. (2012). Does MIS Have Native Theories? *MIS Quarterly*, 36(2), iii-xii.
- Sykes, T. A., Venkatesh, V., & Rai, A. (2011). "Explaining Physicians' Use of EMR Systems and Performamnce in the Shakedown Phase". *Journal of the American Medical Informatics Association*, 18(2), 125-130.
- Tashakkori, A., & Creswell, J. W. (2008). Mixed Methodology Across Disciplines. *Journal of Mixed Methods Research*, 2(1), 3-6.
- Tashakkori, A., & Teddlie, C. (2008). "Quality of Inferences in Mixed Methods Research: Calling for an Integrative Framework". In M. Bergman (Ed.), *Advances in Mixed Methods Research: Theories and Implications*. London: Sage Publications.
- Tdwi. (2015). Business Intelligence. Retrieved from <http://tdwi.org/portals/business-intelligence.aspx>. [Accessed on 20 July 2015]
- Teddlie, C., & Tashakkori, A. (2003). "Major Issues and Controversies in the Use of Mixed Methods in Social and Behavioural Science". In A. Tashakkori and C. Teddlie (Eds.), *Handbook of Mixed Methods in Social and Behavioural Science* (pp. 3-50). Thousand Oaks, CA: Sage Publications.
- Teddlie, C., & Tashakkori, A. (2009). *Foundations of Mixed Methods Research*. Thousand Oaks, CA: Sage Publications.
- Tront, R., & Hoffman, S. (2011). Pervasive Business Intelligence and the Realities of Excel. *Business Intelligence Journal*, 16(4), 8-14.
- Tucker, W. (2009). It is not just a theory, it is a theory! *CAP Journal*(5), 9-10.
- Van Dyk, L. (2008). A data warehouse model for micro-level decision making in higher education *The Electronic Journal of e-Learning*, 6(3), 235-244.
- Van Louw, T., & Beets, P. a. D. (2008). The transformation of higher education: Context of the establishment of the Centre for Leadership and Management in Education at Stellenbosch University. *SAJHE*, 22(3), 473-483.
- Venkatesh, V., Bala, H., & Sykes, T. A. (2010). Impacts of Information and Communication Technology Implementations on Employees' Jobs in India: A multi-Method Longitudinal Field Study. *Production and Operations Management*, 19(5), 591-613.
- Venkatesh, V., Brown, S. A., & Bala, H. (2013). "Bridging the Qualitative-Quantitative Divide: Guidelines for Conducting Mixed Methods Research in Information Systems,". *MIS Quarterly*, 37(1), 21-54.
- Volkoff, O., & Strong, D. M. (2013). Critical Realism and Affordances: Theorizing IT-Associated Organizational Change Processes. *MIS Quarterly*, 37(3), 819-834.

- Wagner, H., & Weitzel, T. (2012). How to Achieve Operational Business-IT Alignment: Insights from a Global Aerospace Firm. *MIS Quarterly Executive*, 11(1), 25-36.
- Waheed, K. S. (2011). Four Strategies for Increasing Business Intelligence Usage. *Business Intelligence Journal*, 16(4), 34-38.
- Watson, H. J. (2011). Business Analytics Insight: Hype or Here to Stay? *Business Intelligence Journal*, 16(1), 4-8.
- Watson, H. J. (2012a). Soft Skills for Professional Success. *Business Intelligence Journal*, 17(3), 4-8.
- Watson, H. J. (2012b). This Isn't Your Mother's BI Architecture. *Business Intelligence Journal*, 17(1), 4-6.
- Watson, H. J., & Leornard, T. (2011). U.S. Xpress: Where Trucks and BI Hit the Road. *Business Intelligence Journal*, 16(2), 4-7.
- Weir, R. (2012). Why Data Integrity Starts with Strong Leadership. *Business Intelligence Journal*, 17(1), 46-56.
- Weiss, M. (2012). APC Forum: Harvesting Digital Data Streams. *MIS Quarterly*, 11(4), 205-206.
- Williams, C. K., & Karahanna, E. (2013). CAUSAL EXPLANATION IN THE COORDINATING PROCESS: A CRITICAL REALIST CASE STUDY OF FEDERATED IT GOVERNANCE STRUCTURES. *MIS Quarterly*, 37(3), 933-964.
- Williams, N., & Thomann, J. (2003). BI Maturity and ROI: How Does Your Organization Measure Up? *TDWI Flashpoint*, pp. 1-3.
- Wixom, B. H., Watson, H. J., & Werner, T. (2011). Developing an Enterprise Business Intelligence Capability: The Norfolk Southern Journey. *MIS Quarterly Executive*, 10(2), 61-71.
- Wuensch, K. L. (2012). Principal Components Analysis - SPSS. Retrieved from <http://faculty.ksu.edu.sa/ABID/609QUA/PCA-SPSS.pdf>. [Accessed on 3 December]
- Xuea, W., Pung, H. K., & Sen, S. (2013). Managing context data for diverse operating spaces. *Pervasive and Mobile Computing*, 9(2013), 57-75.
- Young, E. (2012). Using data to drive safety management: The enterprise risk management information system. *Journal of Chemical Health and Safety*, 19(4), 44-54.
- Zachariadis, M., Scott, S., & Barrett, M. (2013). Methodological Implications of Critical Realism for Mixed-Methods Research. *MIS Quarterly*, 37(3), 855-879.

Appendices

A1- Codebook Variable Explanations: BI Survey in South African Higher Education

Variable Sequence Number	Category of Variable	Variable Prefix	Variable Name	Type of Data
1	Public South African University	None	University	Nominal
2	Business and Technology Alignment	BTA	BTAalign	interval
3	Business and Technology Alignment	BTA	BTAquality	interval
4	Business and Technology Alignment	BTA	BTAerrors	interval
5	Business and Technology Alignment	BTA	BTAaccess	interval
6	Business and Technology Alignment	BTA	BTAdecisions	interval
7	Business and Technology Alignment	BTA	BTAtools	interval
8	Business and Technology Alignment	BTA	BTArepaccess	interval
9	Business and Technology Alignment	BTA	BTAwork	interval
10	Organizational and Behavioural Strategies	OBS	OBSpolitics	interval
11	Organizational and Behavioural Strategies	OBS	OBSemc	interval
12	Organizational and Behavioural Strategies	OBS	OBSadopt	interval
13	Organizational and Behavioural Strategies	OBS	OBSskills	interval
14	Organizational and Behavioural Strategies	OBS	OBSdesign	interval
15	Organizational and Behavioural Strategies	OBS	OBSgovernance	interval
16	Organizational and Behavioural Strategies	OBS	OBSdatagov	interval
17	Organizational and Behavioural Strategies	OBS	OBSstratalign	interval
18	Organizational and Behavioural Strategies	OBS	OBSstandards	interval
19	Organizational and Behavioural Strategies	OBS	OBSictprovision	interval
20	Technology Strategies	TS	TSrelations	interval
21	Technology Strategies	TS	TSassess	interval
22	Technology Strategies	TS	TScomms	interval
23	Technology Strategies	TS	TSplan	interval
24	Technology Strategies	TS	TSadopten	interval
25	Technology Strategies	TS	TStraining	interval
26	Technology Strategies	TS	TSmethods	interval
27	Technology Strategies	TS	TSrepstandards	interval
28	Technology Strategies	TS	TSvarusers	interval
29	Business Intelligence	BI	BIintelligence	Text
30	Business Intelligence	BI	BIalternative	Text
31	Business Intelligence	BI	BIfrequency	interval
32	Business Intelligence	BI	BIframework	Text
33	Business Intelligence	BI	BI_AnalFramework	interval
34	Business Intelligence	BI	BI_DataArchitecture	interval
35	Business Intelligence	BI	BI_Datawarehouse	interval
36	Business Intelligence	BI	BI_UserSupport	interval
37	Technology Strategies	TS	TSHETDATAACC_S	interval

A2- Codebook Business Intelligence Survey Items

variable name	variable label	value	value label	Data Level
University	Which University are you from?	1 to 26		Nominal
BTAalign	How satisfied are you with and what is the importance of the business intelligence technology in providing insights into the university core business processes?	1 to 6		Interval
		1 to 6		Interval
BTAsystem	How satisfied are you with and what is the importance of the Business Intelligence System response time (up-time and down-time)?	1 to 6		Interval
		1 to 6		Interval
BTAquality	How satisfied are you with and what is the importance of the Quality levels of technical support provided to the business intelligence system?	1 to 6		Interval
		1 to 6		Interval
BTAerrors	How satisfied are you with and what is the importance of the frequency of the business Intelligence System Errors?	1 to 6		Interval
		1 to 6		Interval
BTAaccess	How satisfied are you with and what is the importance of the online access of the reports from the business intelligence system?	1 to 6		Interval
		1 to 6		Interval
BTAdecisions	How satisfied are you with and what is the importance of top decision areas being addressed by the business intelligence system?	1 to 6		Interval
		1 to 6		Interval
BTAtools	How satisfied are you with and what is the importance of business intelligence tools in decision-making processes within your university?	1 to 6		Interval
		1 to 6		Interval
BTArepaccess	How satisfied are you with and what is the importance of accessing reports from a single area?	1 to 6		Interval
		1 to 6		Interval
BTAwork	How satisfied are you with and what is the importance of information technology services working together with other university business core teams?	1 to 6		Interval
		1 to 6		Interval
OBSpolitics	How satisfied are you with and what is the importance of understanding the politics that exist within your institution?	1 to 6		Interval
		1 to 6		Interval
OBSemc	How satisfied are you with and what is the importance of executive management support in business intelligence initiatives?	1 to 6		Interval
		1 to 6		Interval
OBSadopt	How satisfied are you with and what is the importance of user adoption of business intelligence solution?	1 to 6		Interval
		1 to 6		Interval
OBSskills	How satisfied are you with and what is the importance of competence levels in business intelligence systems?	1 to 6		Interval
		1 to 6		Interval
OBSdesign	How satisfied are you with and what is the importance of competence levels in business intelligence systems?	1 to 6		Interval
		1 to 6		Interval
OBSgovernance	How satisfied are you with and what is the importance of information technology governance alignment within your institution?	1 to 6		Interval
		1 to 6		Interval
OBSdatagov	How satisfied are you with and what is the importance of data governance alignment within your institution?	1 to 6		Interval
		1 to 6		Interval
OBSstratalign	How satisfied are you with and what is the importance of university core business strategy alignment with business intelligence systems within your institution?	1 to 6		Interval
		1 to 6		Interval
OBSstandards	How satisfied are you with and what is the importance of business intelligence standards within your institution?	1 to 6		Interval
		1 to 6		Interval
OBSictprovision	How satisfied are you with and what is the importance of ICT provisioning within your institution?	1 to 6		Interval
		1 to 6		Interval
TSrelations		1 to 6		Interval

APPENDICES

	How satisfied are you with and what is the importance of the relationship between ICT services (which include business intelligence systems) and the core university business teams within your institution?	1 to 6		Interval
TSassess	How satisfied are you with and what is the importance of the assessment of ICT provisioning including business intelligence provisioning within your institution?	1 to 6		Interval
		1 to 6		Interval
TScomms	How satisfied are you with and what is the importance of a communication plan for business intelligence provisioning within your institution?	1 to 6		Interval
		1 to 6		Interval
TSplan	How satisfied are you with and what is the importance of a business plan for business intelligence provisioning within your institution?	1 to 6		Interval
		1 to 6		Interval
TSadopten	How satisfied are you with and what is the importance of user adoption enablement of business intelligence systems within your institution?	1 to 6		Interval
		1 to 6		Interval
TStraining	How satisfied are you with and what is the importance of user training plans for business intelligence systems usage within your institution?	1 to 6		Interval
		1 to 6		Interval
TSmethods	How satisfied are you with and what is the importance of a methodological approach to business intelligence systems implementation within your institution?	1 to 6		Interval
		1 to 6		Interval
TSrepstandards	How satisfied are you with and what is the importance of having business intelligence standards within your institution?	1 to 6		Interval
		1 to 6		Interval
TSvarusers	How satisfied are you with and what is the importance of having a business intelligence system that supports various types of users within your institution?	1 to 6		Interval
		1 to 6		Interval
UserSupport	How satisfied are you with and what is the importance of having a business intelligence system that supports various types of users within your institution?	1 to 6		Interval
		1 to 6		Interval
BI_Datawarehouse	How satisfied are you with and what is the importance of having an enterprise data warehouse within your institution?	1 to 6		Interval
		1 to 6		Interval
BI_DataArchitecture	How satisfied are you with and what is the importance of the data architecture within your institution?	1 to 6		Interval
		1 to 6		Interval
BI_AnalFramework	How satisfied are you with and what is the importance of the data analysis framework used by the business intelligence system within your institution?	1 to 6		Interval
		1 to 6		Interval
Blintelligence		open text box	n/a	Text
Blalternative	What is the probable alternative to the current Business Intelligence System being used at your institution?	open text box	n/a	Text
Blrepfrequency	Judging with your experience this far of using the business intelligence system within your institution, How frequently do you develop your own personalised reports?	1	Never/Rarely	Interval
		2	Sometimes	
		3	Often	
		4	Very Often	
Blframework	If you have used any methodology in implementing business intelligence systems within your institution, briefly describe such methodology in the text box provided.	open text box	n/a	Text
TSHETDATAACC_S		1 to 6		Interval

APPENDICES

	How satisfied are you with and what is the importance of data quality for the business intelligence system within your institution?	1 to 6		Interval

A3- Codebook Data Dictionary: BI Survey in South African Higher Education

Variable Name	Variable Value	Valid Values	
University	Name of public South African university	Public South African Universities	
BTAalign	Technology and Business alignment	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
BTAsystem	System Response time	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
BTAquality	Quality of Technical support	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
BTAsyserrors	Frequency of System Errors	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
BTAaccess	Access to data and reports via the internet	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
BTAdecisions	Top decision areas are addressed and prioritised in the information system	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
BTAtools	Business intelligence tools to support decision making processes	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
BTArepaccess	Access of data and reports from a single area	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
BTAwork	IT and University core business teams working together	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
OBSpolitics	Understanding the institutional culture and politics that exist and obstacles to look for change	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important

APPENDICES

OBSemc	Executive management support	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
OBSadopt	User adoption of the business intelligence technology	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
OBSskills	Business intelligence competency and skills	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
OBSdesign	Organizational design approaches for business intelligence tools	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
OBSgovernance	IT governance alignment	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
OBSdatagov	Data governance alignment	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
OBSstratalign	Business Strategy alignment	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
OBSstandards	Creating technology standards	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
OBSictprovision	Provision of ICT accessibility	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
TSrelations	Relationship between BI/IT and core business of the institution	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important
		6=Extremely Satisfied	6=Extremely Important
TSassess	Assessment of current BI/IT and business relationship	1=Extremely Unsatisfied	1=Not Important
		2=Very Unsatisfied	2=Not so Important
		3=Unsatisfied	3=Slightly Important
		4=Satisfied	4=Important
		5=Very Satisfied	5=Very Important

APPENDICES

		6=Extremely Satisfied	6=Extremely Important
TScomms	Communication Plan to various stakeholders for BI/IT implementations	1=Extremely Unsatisfied 2=Very Unsatisfied 3=Unsatisfied 4=Satisfied 5=Very Satisfied 6=Extremely Satisfied	1=Not Important 2=Not so Important 3=Slightly Important 4=Important 5=Very Important 6=Extremely Important
TSplan	Organizational Plan to establish a business case for BI investment	1=Extremely Unsatisfied 2=Very Unsatisfied 3=Unsatisfied 4=Satisfied 5=Very Satisfied 6=Extremely Satisfied	1=Not Important 2=Not so Important 3=Slightly Important 4=Important 5=Very Important 6=Extremely Important
TSadopten	User adoption enablement	1=Extremely Unsatisfied 2=Very Unsatisfied 3=Unsatisfied 4=Satisfied 5=Very Satisfied 6=Extremely Satisfied	1=Not Important 2=Not so Important 3=Slightly Important 4=Important 5=Very Important 6=Extremely Important
TStraining	Training plan for the users	1=Extremely Unsatisfied 2=Very Unsatisfied 3=Unsatisfied 4=Satisfied 5=Very Satisfied 6=Extremely Satisfied	1=Not Important 2=Not so Important 3=Slightly Important 4=Important 5=Very Important 6=Extremely Important
TSmethods	Methodological processes for BI implementations	1=Extremely Unsatisfied 2=Very Unsatisfied 3=Unsatisfied 4=Satisfied 5=Very Satisfied 6=Extremely Satisfied	1=Not Important 2=Not so Important 3=Slightly Important 4=Important 5=Very Important 6=Extremely Important
TSrepstandards	Business intelligence standards	1=Extremely Unsatisfied 2=Very Unsatisfied 3=Unsatisfied 4=Satisfied 5=Very Satisfied 6=Extremely Satisfied	1=Not Important 2=Not so Important 3=Slightly Important 4=Important 5=Very Important 6=Extremely Important
TSvarusers	Support of a broad range of users	1=Extremely Unsatisfied 2=Very Unsatisfied 3=Unsatisfied 4=Satisfied 5=Very Satisfied 6=Extremely Satisfied	1=Not Important 2=Not so Important 3=Slightly Important 4=Important 5=Very Important 6=Extremely Important
BIntelligence	Business Intelligence System Used	Open Text	
BAlternative	Business Intelligence System Alternative	Open Text	
Brepfrequency	Frequency of developing reports	1=Never/Rarely 2=Sometimes 3=Often 4=Very Often	
BIframework	Business Intelligence Framework usage	Open Text	

B1- Codebook Data Dictionary: Technology Acceptance Survey at University of Venda

variable name	variable label	value	value label	Data Level
PEUconsult	It is difficult to use the Business Intelligence System (HEDA) without consulting others	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
PEUlearn	Learning to use the Business Intelligence System (HEDA) is easy	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
PEUstatistics	The reports from the Business Intelligence System (HEDA) are easy to obtain	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
PEUinteraction	The interface of the Business Intelligence System (HEDA) is easy to use	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
PEUrecover	Recovering from the errors I get when using the Business Intelligence System (HEDA) is easy.	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
PUSdecisions	Using the Business Intelligence System (HEDA) enhance my decision-making capabilities	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
PUScontrol	Using the Business Intelligence System (HEDA) gives me greater control over my work	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	

PUSperformance	The Business Intelligence System (HEDA) improves my job performance	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
PUSinformation	The Business Intelligence System (HEDA) allows me to have access to valuable institutional information	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
PUSusefulness	Overall, the Business Intelligence System (HEDA) is useful system at the University of Venda	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
ATUthinking	I think the Business Intelligence System (HEDA) is a worthwhile investment at the University of Venda	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
ATUfavourable	I have a favourable attitude towards using the Business Intelligence System (HEDA).	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
ATUbelief	I believe it is a good idea to use the Business Intelligence System (HEDA) for my work.	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
ATUlike	I like the idea of using the Business Intelligence System (HEDA) for management information.	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
ATUenjoy	Using the Business Intelligence System (HEDA) for management information provides me with a lot of enjoyment.	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	

		5	Agree	
		6	Strongly Agree	
INTUintend	I intend to use the Business Intelligence System (HEDA) for most of my data needs.	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
INTUfrequency	I intend to use the Business Intelligence System (HEDA) frequently for most of my data needs.	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
INTUoftenly	I intend to use the Business Intelligence System (HEDA) as often as possible.	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
INTUplanning	I am planning to use the Business Intelligence System (HEDA) in the future.	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
INTUexpect	I expect my use of the Business Intelligence System (HEDA) to continue in the future.	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
FFAavailable	The Business Intelligence System (HEDA) is always available when I need it	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
FFAassistance	I am always provided with assistance to use the Business Intelligence System (HEDA) when I need it	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
FFAhelpdocs	The documents and procedure manuals provided in the Business Intelligence	1	Strongly Disagree	Interval
		2	Disagree	

APPENDICES

	System (HEDA) facilitate my usage of the system	3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
FFAmanagement	The Management at University of Venda facilitate my usage of the Business Intelligence System (HEDA)	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
ACTUfrequency	Have you used the Business Intelligence (HEDA) System before?	1	Strongly Disagree	Interval
		2	Disagree	
		3	Neither Agree or Disagree	
		4	Slightly Agree	
		5	Agree	
		6	Strongly Agree	
ACTUusage	Have you used the Business Intelligence (HEDA) System before?	1	Never/Rarely	Interval
		2	Sometimes	
		3	Often	
		4	Very Often	
ACTUfrequency	During the course of this year how often have you used the Business Intelligence System or its services?	1	Not at all	Interval
		2	About once each month	
		3	A few times a month	
		4	About once a week	
		5	About once a day	
		6	Several times a day	
EXPyears	Kindly state, how many years have you been using computers?	1	Less than a year	Interval
		2	2 to 5 years	
		3	6 to 10 years	
		4	More than 10 years	
DEMage	Your current age in falls into which of the age group?	1	Less than 25 years	Interval
		2	26 - 35 years	
		3	36 - 45 years	
		4	46 - 55 years	
		5	Above 55 years	

B2- Codebook Variable Explanations: TAM Survey at the University of Venda

Variable Sequence Number	Technology Acceptance Model Category	Variable Prefix	Variable Name	Type of Data
1	Perceived Ease of Use	PEU	PEUconsult	Interval
2	Perceived Ease of Use	PEU	PEUlearn	Interval
3	Perceived Ease of Use	PEU	PEUstatistics	Interval
4	Perceived Ease of Use	PEU	PEUinteraction	Interval
5	Perceived Ease of Use	PEU	PEUrecover	Interval
6	Perceived Usefulness	PUS	PUSdecisions	Interval
7	Perceived Usefulness	PUS	PUScontrol	Interval
8	Perceived Usefulness	PUS	PUSperformance	Interval
9	Perceived Usefulness	PUS	PUSinformation	Interval
10	Perceived Usefulness	PUS	PUSusefulness	Interval
11	Attitude Towards Using	ATU	ATUthinking	Interval
12	Attitude Towards Using	ATU	ATUfavourable	Interval
13	Attitude Towards Using	ATU	ATUbelief	Interval
14	Attitude Towards Using	ATU	ATUlike	Interval
15	Attitude Towards Using	ATU	ATUenjoy	Interval
16	Intentions to Use	INTU	INTUintend	Interval
17	Intentions to Use	INTU	INTUfrequency	Interval
18	Intentions to Use	INTU	INTUoftenly	Interval
19	Intentions to Use	INTU	INTUplanning	Interval
20	Intentions to Use	INTU	INTUexpect	Interval
21	Facilitating Factors	FFA	FFAavailable	Interval
22	Facilitating Factors	FFA	FFAassistance	Interval
23	Facilitating Factors	FFA	FFAhelpdocs	Interval
24	Facilitating Factors	FFA	FFAmanagement	Interval
25	Actual Usage	ACTU	ACTUfrequency	Interval
26	Actual Usage	ACTU	ACTUusage	Interval
27	Actual Usage	ACTU	ACTUfrequency	Interval
28	Experience (<i>in years</i>) of Using Computers	EXP	EXPyears	Interval
29	Demographic Data (<i>Age</i>)	DEM	DEMage	Interval

C1- Phase I - Results of Pilot Data Analysis: Satisfactory factors

Communalities		
	Initial	Extraction
BTAlign_S	1.000	.759
BTASystem_S	1.000	.800
BTQuality_S	1.000	.785
BTAsyserrors_S	1.000	.728
BTAAccess_S	1.000	.744
BTAdisions_S	1.000	.761
BTATools_S	1.000	.756
BTArepass_S	1.000	.816
BTWork_S	1.000	.742
OBSPolitics_S	1.000	.841
OBSEmc_S	1.000	.839
OBSSadopt_S	1.000	.637
OBSSkills_S	1.000	.762
OBSSdesign_S	1.000	.761
OBSSgovernance_S	1.000	.836
OBSSdatagov_S	1.000	.702
OBSSstratalign_S	1.000	.777
OBSSstandards_S	1.000	.807
OBSSictprovision_S	1.000	.855
Tsrelations_S	1.000	.837
Tsassess_S	1.000	.841
Tscomms_S	1.000	.853
Tsplan_S	1.000	.843
Tsadopten_S	1.000	.706
Tstraining_S	1.000	.689
Tsmethods_S	1.000	.697
Tsrepstandards_S	1.000	.737
Tsvarusers_S	1.000	.783
TSBIStandards_S	1.000	.838
TSHETDATACC_S	1.000	.773
BI_UserSupport_S	1.000	.800
BI_Datawarehouse_S	1.000	.766
BI_DataArchitecture_S	1.000	.769
BI_AnalFramework_S	1.000	.840
Extraction Method: Principal Component Analysis.		

C2- Phase I - Results of Pilot Data Analysis: Importance factors

Communalities		
	Initial	Extraction
BTAlign_I	1.000	.734
BTAsystem_I	1.000	.804
BTQuality_I	1.000	.812
BTAsyserrors_I	1.000	.883
BTAccess_I	1.000	.838
BTAdisions_I	1.000	.818
BTAtools_I	1.000	.746
BTArepass_I	1.000	.809
BTWork_I	1.000	.704
OBSpolitics_I	1.000	.695
OBSemc_I	1.000	.713
OBSadopt_I	1.000	.753
OBSskills_I	1.000	.772
OBSdesign_I	1.000	.749
OBSgovernance_I	1.000	.770
OBSdatagov_I	1.000	.552
OBSstratalign_I	1.000	.839
OBSstandards_I	1.000	.722
OBSictprovision_I	1.000	.700
Tsrelations_I	1.000	.655
Tsassess_I	1.000	.730
Tscomms_I	1.000	.669
Tsplan_I	1.000	.746
Tsadopten_I	1.000	.818
Tstraining_I	1.000	.740
Tsmethods_I	1.000	.833
Tsrepstandards_I	1.000	.729
Tsvarusers_I	1.000	.775
TSBIStandards_I	1.000	.842
TSHETDATAACC_I	1.000	.731
BI_UserSupport_I	1.000	.780
BI_Datawarehouse_I	1.000	.678
BI_DataArchitecture_I	1.000	.788
BI_AnalFramework_I	1.000	.771
Extraction Method: Principal Component Analysis.		

D1- Phase II – Descriptive Statistics Quantitative Data Analysis: Satisfactory factors

Descriptive Statistics			
	Mean	Std. Deviation	Analysis N
BTAalign_S	4.13	.525	258
BTAsystem_S	4.14	.510	258
BTAquality_S	4.22	.538	258
BTAyserrors_S	4.21	.632	258
BTAaccess_S	4.26	.595	258
BTAdecisions_S	4.10	.649	258
BTAtools_S	4.13	.588	258
BTArepaccess_S	4.14	.651	258
BTAwork_S	4.23	.642	258
OBSpolitics_S	4.08	.670	258
OBSemc_S	4.23	.605	258
OBSadopt_S	4.06	.655	258
OBSskills_S	4.52	.586	258
OBSdesign_S	4.17	.703	258
OBSgovernance_S	4.15	.675	258
OBSdatagov_S	3.98	.916	258
OBSstratalign_S	4.07	.745	258
OBSstandards_S	4.07	.729	258
OBSictprovision_S	4.13	.730	258
Tsrelations_S	4.12	.673	258
Tsassess_S	4.09	.727	258
Tscomms_S	4.22	.707	258
Tsplan_S	4.21	.719	258
Tsadopten_S	4.23	.711	258
Tstraining_S	4.24	.665	258
Tsmethods_S	4.72	.475	258
Tsrepstandards_S	4.23	.624	258
Tsvarusers_S	4.24	.629	258
TSBIStandards_S	4.24	.610	258
TSHETDATAACC_S	4.33	.656	258
BI_UserSupport_S	4.30	.650	258
BI_Datawarehouse_S	4.23	.642	258
BI_DataArchitecture_S	4.29	.646	258
BI_AnalFramework_S	4.33	.620	258

D2 – Latent and Observed BI Variables Coding used in the Data Analysis

Business Intelligence Dimension	Variable	Variable Code	Business Intelligence Characteristics
Business Intelligence	BI_AnalFramework	V34	Business Intelligence Analytical Framework
	BI_DataArchitecture	V33	Business Intelligence Data Architecture
	BI_Datawarehouse	V32	Enterprise Data Warehouse
	BI_UserSupport	V31	Business Intelligence Users Support
Business and Technology Alignment	BTAAccess	V5	Access to data and reports via the internet
	BTAAalign	V1	Technology and Business alignment
	BTAdecisions	V6	Top decision areas are addressed and prioritised in the information system
	BTAAquality	V3	Quality of Technical support
	BTAreaccess	V8	Access of data and reports from a single area
	BTAsyserrors	V4	Frequency of System Errors
	BTASystem	V2	Business Intelligence System Response time
	BTAtools	V7	Business intelligence tools to support decision making processes
	BTAAwork	V9	IT and University core business teams working together
Organizational and Behavioural Strategies	OBSadopt	V12	User adoption of the business intelligence technology
	OBSdatagov	V16	Data governance alignment
	OBSdesign	V14	Organizational design approaches for business intelligence tools
	OBSemc	V11	Executive management support
	OBSgovernance	V15	IT governance alignment
	OBSictprovision	V19	Provision of ICT accessibility
	OBSpolitics	V10	Understanding the institutional culture and politics that exist and obstacles to look for change
	OBSskills	V13	Business intelligence competency and skills
	OBSstandards	V18	Creating technology standards
	OBSstratalign	V17	Business Strategy alignment
Technology Strategies	TSadopten	V24	User adoption enablement
	TSassess	V21	Assessment of current BI/IT and business relationship
	TSBIStandards	V29	Business Intelligence Standards and Frameworks
	TScomms	V22	Communication Plan to various stakeholders for BI/IT implementations
	TSHETDATAACC	V30	Business Intelligence data quality
	TSmethods	V26	Methodological processes for BI implementations
	TSplan	V23	Organizational Plan to establish a business case for BI investment
	TSrelations	V20	Relationship between BI/IT and core business of the institution
	TSrepstandards	V27	Business intelligence standards
	TStraining	V25	Training plan for the users
	TSvarusers	V28	Support of a broad range of users

D3 – Latent and Observed Importance BI Variables Coding used in the Analysis

Business Intelligence Dimension	Variables	Variable Code	Business Intelligence Characteristics
Business Intelligence	BI_AnalFramework_I	IMP_34	Business Intelligence Analytical Framework
	BI_DataArchitecture_I	IMP_33	Business Intelligence Data Architecture
	BI_Datawarehouse_I	IMP_32	Enterprise Data Warehouse
	BI_UserSupport_I	IMP_31	Business Intelligence Users Support
Business and Technology Alignment	BTAccess_I	IMP_5	Access to data and reports via the internet
	BTAlign_I	IMP_1	Technology and Business alignment
	BTAdisions_I	IMP_6	Top decision areas are addressed and prioritised in the information system
	BTQuality_I	IMP_3	Quality of Technical support
	BTArepass_I	IMP_8	Access of data and reports from a single area
	BTAsyserrors_I	IMP_4	Frequency of System Errors
	BTAsystem_I	IMP_2	Business Intelligence System Response time
	BTAtools_I	IMP_7	Business intelligence tools to support decision making processes
	BTWork_I	IMP_9	IT and University core business teams working together
Organizational and Behavioural Strategies	OBSadopt_I	IMP_12	User adoption of the business intelligence technology
	OBSdatagov_I	IMP_16	Data governance alignment
	OBSdesign_I	IMP_14	Organizational design approaches for business intelligence tools
	OBSemc_I	IMP_11	Executive management support
	OBSgovernance_I	IMP_15	IT governance alignment
	OBSictprovision_I	IMP_19	Provision of ICT accessibility
	OBSpolitics_I	IMP_10	Understanding the institutional culture and politics that exist and obstacles to look for change
	OBSskills_I	IMP_13	Business intelligence competency and skills
	OBSstandards_I	IMP_18	Creating technology standards
	OBSstratalign_I	IMP_17	Business Strategy alignment
Technology Strategies	TSadopten_I	IMP_24	User adoption enablement
	TSassess_I	IMP_21	Assessment of current BI/IT and business relationship
	TSBIStandards_I	IMP_29	Business Intelligence Standards and Frameworks
	TScomms_I	IMP_22	Communication Plan to various stakeholders for BI/IT implementations
	TSHETDATAACC_I	IMP_30	Business Intelligence data quality
	TSmethods_I	IMP_26	Methodological processes for BI implementations
	TSplan_I	IMP_23	Organizational Plan to establish a business case for BI investment
	TSrelations_I	IMP_20	Relationship between BI/IT and core business of the institution
	TSrepstandards_I	IMP_27	Business intelligence standards
	TStraing_I	IMP_25	Training plan for the users
	TSvarusers_I	IMP_28	Support of a broad range of users

D4 – Latent and Observed Satisfactory BI Variables Coding used in the Analysis

Business Intelligence Dimension	Variable	Variable Code	Business Intelligence Characteristics
Business Intelligence	BI_AnalFramework_S	SAT_34	Business Intelligence Analytical Framework
	BI_DataArchitecture_S	SAT_33	Business Intelligence Data Architecture
	BI_Datawarehouse_S	SAT_32	Enterprise Data Warehouse
	BI_UserSupport_S	SAT_31	Business Intelligence Users Support
Business and Technology Alignment	BTAaccess_S	SAT_5	Access to data and reports via the internet
	BTAalign_S	SAT_1	Technology and Business alignment
	BTAdecisions_S	SAT_6	Top decision areas are addressed and prioritised in the information system
	BTAquality_S	SAT_3	Quality of Technical support
	BTArepaccess_S	SAT_8	Access of data and reports from a single area
	BTAerrors_S	SAT_4	Frequency of System Errors
	BTAstystem_S	SAT_2	Business Intelligence System Response time
	BTAtools_S	SAT_7	Business intelligence tools to support decision making processes
	BTAwork_S	SAT_9	IT and University core business teams working together
Organizational and Behavioural Strategies	OBStadopt_S	SAT_12	User adoption of the business intelligence technology
	OBStatagov_S	SAT_16	Data governance alignment
	OBStesign_S	SAT_14	Organizational design approaches for business intelligence tools
	OBStsemc_S	SAT_11	Executive management support
	OBStgovernance_S	SAT_15	IT governance alignment
	OBStictprovision_S	SAT_19	Provision of ICT accessibility
	OBStpolitics_S	SAT_10	Understanding the institutional culture and politics that exist and obstacles to look for change
	OBStskills_S	SAT_13	Business intelligence competency and skills
	OBStstandards_S	SAT_18	Creating technology standards
	OBStstratalign_S	SAT_17	Business Strategy alignment
Technology Strategies	TSadopen_S	SAT_24	User adoption enablement
	TSassess_S	SAT_21	Assessment of current BI/IT and business relationship
	TSBIStandards_S	SAT_29	Business Intelligence Standards and Frameworks
	TScomms_S	SAT_22	Communication Plan to various stakeholders for BI/IT implementations
	TSHETDATAACC_S	SAT_30	Business Intelligence data quality
	TSmethods_S	SAT_26	Methodological processes for BI implementations
	TSplan_S	SAT_23	Organizational Plan to establish a business case for BI investment
	TSrelations_S	SAT_20	Relationship between BI/IT and core business of the institution
	TSrepstandards_S	SAT_27	Business intelligence standards
	TStraining_S	SAT_25	Training plan for the users
	TSvarusers_S	SAT_28	Support of a broad range of users

D5 - Observed Importance Business Intelligence Variables Communalities

Communalities		
	Initial	Extraction
BTAlign_I	1.000	.734
BTASystem_I	1.000	.804
BTAQuality_I	1.000	.812
BTASyserrors_I	1.000	.883
BTAaccess_I	1.000	.838
BTAdecisions_I	1.000	.818
BTAtools_I	1.000	.746
BTArepaccess_I	1.000	.809
BTAwork_I	1.000	.704
OBSpolitics_I	1.000	.695
OBSemc_I	1.000	.713
OBSadopt_I	1.000	.753
OBSskills_I	1.000	.772
OBSdesign_I	1.000	.749
OBSgovernance_I	1.000	.770
OBSdatagov_I	1.000	.552
OBSstratalign_I	1.000	.839
OBSstandards_I	1.000	.722
OBSictprovision_I	1.000	.700
TSrelations_I	1.000	.655
TSassess_I	1.000	.730
TScomms_I	1.000	.669
TSplan_I	1.000	.746
TSadopten_I	1.000	.818
TStraining_I	1.000	.740
TSmethods_I	1.000	.833
TSrepstandards_I	1.000	.729
TSvarusers_I	1.000	.775
TSBIStandards_I	1.000	.842
TSHETDATAACC_I	1.000	.731
BI_UserSupport_I	1.000	.780
BI_Datawarehouse_I	1.000	.678
BI_DataArchitecture_I	1.000	.788
BI_AnalFramework_I	1.000	.771
Extraction Method: Principal Component Analysis.		

D6- Observed Satisfactory Business Intelligence Variables Factor Loadings

Component Matrix ^a					
	Component				
	1	2	3	4	5
OBStprovision_S	.854	-.191	-.279	-.032	-.103
TSplan_S	.851	-.272	-.152	-.008	.146
TScomms_S	.850	-.154	-.251	-.038	.206
OBStgovernance_S	.838	-.168	-.276	.096	.141
OBStstandards_S	.830	-.255	-.211	.090	.020
OBStstratalign_S	.829	-.208	-.175	.121	-.025
OBStdesign_S	.822	-.120	-.159	-.094	.191
TSassess_S	.815	-.240	-.318	-.106	-.089
TSBIStandards_S	.813	-.129	.300	-.157	.215
OBStsemc_S	.808	.342	-.041	.042	-.255
TSrelations_S	.803	-.196	-.392	-.005	-.006
BI_AnalFramework_S	.803	-.119	.374	-.144	.144
TSadopten_S	.780	-.099	.219	.111	-.164
BTArepass_S	.777	.411	-.102	.089	-.162
BI_UserSupport_S	.775	-.307	.210	-.055	-.239
OBStpolitics_S	.775	.294	-.095	.025	-.380
TSrepstandards_S	.773	-.228	.284	-.057	.054
OBStadopt_S	.770	-.029	-.170	-.118	-.006
BI_Datawarehouse_S	.769	-.223	.301	.024	-.183
TSHETDATAACC_S	.768	-.132	.385	-.127	.039
TSvarusers_S	.760	-.157	.387	-.163	.061
TStraining_S	.755	-.288	-.062	-.058	-.170
BTAtools_S	.750	.425	-.069	-.015	-.091
BTAtwork_S	.748	.427	.004	-.022	-.002
OBStdatagov_S	.743	-.300	-.226	-.007	.095
BTAsyserrors_S	.739	.372	-.071	.143	.133
BI_DataArchitecture_S	.727	-.310	.355	-.085	-.107
BTAdisions_S	.684	.399	-.052	.184	-.312
BTAtquality_S	.669	.546	.088	-.075	.163
BTAsystem_S	.658	.473	.106	-.143	.335
BTAtaccess_S	.649	.497	.040	.184	.201
BTAtalign_S	.620	.583	.163	-.025	.086
OBStskills_S	.297	-.214	.001	.710	.353
TSmethods_S	.189	-.168	.379	.688	-.129
Extraction Method: Principal Component Analysis.					
a. 5 components extracted.					

D7- Observed Satisfactory BI Variables Factor Loadings Rotated Component Matrix

Rotated Component Matrix ^a					
	Component				
	1	2	3	4	5
TSrelations_S	.845	.263	.203	.027	.108
TSassess_S	.816	.221	.308	-.059	.169
OBSictprovision_S	.794	.286	.321	.012	.199
OBSgovernance_S	.792	.330	.266	.168	-.019
TScomms_S	.785	.347	.319	.055	-.105
OBSstandards_S	.770	.241	.346	.169	.091
TSplan_S	.764	.248	.427	.112	-.050
OBSdatagov_S	.750	.159	.327	.084	-.010
OBSstratalign_S	.723	.278	.348	.191	.140
OBSdesign_S	.693	.359	.375	.009	-.105
TStraining_S	.624	.149	.471	.025	.235
OBSadopt_S	.613	.384	.320	-.066	.082
BTAalign_S	.059	.833	.248	-.008	-.001
BTAquality_S	.162	.832	.241	-.047	-.077
BTAaccess_S	.200	.799	.144	.201	-.073
BTAsystem_S	.188	.781	.287	-.070	-.261
BTAwork_S	.300	.760	.254	-.013	.102
BTArepaccess_S	.378	.749	.173	.051	.283
BTAtools_S	.341	.748	.203	-.034	.193
BTAyserrors_S	.375	.731	.167	.158	-.003
OBSemc_S	.379	.698	.273	.018	.365
BTAdecisions_S	.278	.679	.145	.120	.433
OBSpolitics_S	.402	.625	.240	-.024	.481
TSvarusers_S	.304	.290	.778	.031	-.024
BI_DataArchitecture_S	.351	.131	.774	.093	.145
BI_AnalFramework_S	.332	.355	.769	.058	-.094
TSHETDATAACC_S	.298	.315	.762	.058	.006
TSBIStandards_S	.396	.357	.725	.045	-.162
TSrepstandards_S	.406	.241	.706	.123	.004
BI_Datawarehouse_S	.369	.223	.701	.164	.249
BI_UserSupport_S	.462	.144	.688	.076	.292
TSadopten_S	.380	.336	.581	.216	.255
OBSskills_S	.297	.062	.036	.793	-.201
TSmethods_S	-.077	-.002	.260	.752	.239
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					
a. Rotation converged in 6 iterations.					

APPENDICES

D8- Inter- Correlation Matrix of BI Satisfactory Variables

	SAT_1	SAT_2	SAT_3	SAT_4	SAT_5	SAT_6	SAT_7	SAT_8	SAT_9	SAT_10	SAT_11	SAT_12	SAT_13	SAT_14	SAT_15	SAT_16	SAT_17	SAT_18	SAT_19	SAT_20	SAT_21	SAT_22	SAT_23	SAT_24	SAT_25	SAT_26	SAT_27	SAT_28	SAT_29	SAT_30	SAT_31	SAT_32	SAT_33	SAT_34
SAT_1	1.00	0.76	0.77	0.62	0.64	0.61	0.70	0.63	0.64	0.57	0.64	0.49	0.05	0.38	0.37	0.25	0.34	0.37	0.41	0.39	0.37	0.43	0.33	0.42	0.28	0.14	0.41	0.47	0.49	0.45	0.30	0.33	0.37	0.45
SAT_2	0.76	1.00	0.74	0.67	0.65	0.48	0.60	0.64	0.65	0.55	0.57	0.46	0.07	0.55	0.48	0.38	0.43	0.41	0.42	0.39	0.37	0.50	0.46	0.42	0.38	0.02	0.45	0.51	0.56	0.49	0.29	0.36	0.34	0.56
SAT_3	0.77	0.74	1.00	0.72	0.70	0.67	0.65	0.64	0.70	0.60	0.63	0.49	0.11	0.51	0.45	0.39	0.40	0.41	0.43	0.38	0.39	0.45	0.42	0.44	0.34	-0.03	0.40	0.46	0.51	0.46	0.38	0.42	0.39	0.52
SAT_4	0.62	0.67	0.72	1.00	0.69	0.71	0.62	0.67	0.63	0.59	0.73	0.56	0.27	0.57	0.58	0.49	0.51	0.50	0.57	0.55	0.57	0.60	0.52	0.51	0.43	0.12	0.44	0.46	0.56	0.48	0.44	0.45	0.39	0.51
SAT_5	0.64	0.65	0.70	0.69	1.00	0.63	0.67	0.69	0.64	0.53	0.64	0.41	0.25	0.51	0.48	0.33	0.46	0.42	0.41	0.39	0.35	0.50	0.47	0.47	0.31	0.09	0.37	0.36	0.47	0.44	0.34	0.45	0.29	0.50
SAT_6	0.61	0.48	0.67	0.71	0.63	1.00	0.67	0.68	0.59	0.71	0.71	0.51	0.16	0.47	0.47	0.42	0.52	0.48	0.56	0.45	0.52	0.41	0.43	0.53	0.45	0.13	0.40	0.37	0.44	0.41	0.48	0.56	0.37	0.38
SAT_7	0.70	0.60	0.65	0.62	0.67	0.67	1.00	0.75	0.79	0.71	0.77	0.59	0.11	0.51	0.57	0.37	0.54	0.55	0.62	0.58	0.49	0.61	0.54	0.51	0.43	0.04	0.49	0.45	0.53	0.50	0.45	0.48	0.39	0.56
SAT_8	0.63	0.64	0.64	0.67	0.69	0.68	0.75	1.00	0.82	0.83	0.81	0.58	0.14	0.58	0.64	0.49	0.63	0.54	0.58	0.55	0.54	0.59	0.51	0.58	0.51	0.13	0.44	0.49	0.50	0.52	0.48	0.48	0.38	0.52
SAT_9	0.64	0.65	0.70	0.63	0.64	0.59	0.79	0.82	1.00	0.74	0.76	0.52	0.14	0.56	0.54	0.41	0.53	0.51	0.51	0.53	0.45	0.63	0.55	0.55	0.44	0.06	0.51	0.52	0.57	0.48	0.42	0.46	0.40	0.60
SAT_10	0.57	0.55	0.60	0.59	0.53	0.71	0.71	0.83	0.74	1.00	0.85	0.55	0.10	0.56	0.57	0.48	0.67	0.61	0.65	0.57	0.61	0.53	0.55	0.60	0.56	0.11	0.51	0.53	0.47	0.52	0.56	0.50	0.46	0.50
SAT_11	0.64	0.57	0.63	0.73	0.64	0.71	0.77	0.81	0.76	0.85	1.00	0.61	0.15	0.56	0.60	0.45	0.59	0.57	0.67	0.59	0.59	0.62	0.59	0.63	0.53	0.10	0.54	0.53	0.54	0.54	0.56	0.55	0.51	0.58
SAT_12	0.49	0.46	0.49	0.56	0.41	0.51	0.59	0.58	0.52	0.55	0.61	1.00	0.16	0.64	0.72	0.62	0.61	0.68	0.69	0.67	0.68	0.68	0.62	0.55	0.58	0.05	0.54	0.53	0.61	0.61	0.59	0.52	0.51	0.53
SAT_13	0.05	0.07	0.11	0.27	0.25	0.16	0.11	0.14	0.14	0.10	0.15	0.16	1.00	0.20	0.36	0.31	0.34	0.35	0.25	0.23	0.19	0.28	0.32	0.27	0.24	0.32	0.24	0.19	0.26	0.19	0.20	0.23	0.24	0.20
SAT_14	0.38	0.55	0.51	0.57	0.51	0.47	0.51	0.58	0.56	0.56	0.56	0.64	0.20	1.00	0.78	0.66	0.78	0.70	0.73	0.70	0.74	0.79	0.81	0.60	0.56	0.08	0.60	0.56	0.69	0.64	0.63	0.61	0.53	0.65
SAT_15	0.37	0.48	0.45	0.58	0.48	0.47	0.57	0.64	0.54	0.57	0.60	0.72	0.36	0.78	1.00	0.74	0.77	0.76	0.79	0.81	0.76	0.83	0.80	0.61	0.62	0.17	0.58	0.55	0.62	0.63	0.64	0.56	0.51	0.58
SAT_16	0.25	0.38	0.39	0.49	0.33	0.42	0.37	0.49	0.41	0.48	0.45	0.62	0.31	0.66	0.74	1.00	0.74	0.79	0.72	0.67	0.69	0.66	0.70	0.51	0.68	0.07	0.54	0.52	0.57	0.54	0.60	0.56	0.56	0.59
SAT_17	0.34	0.43	0.40	0.51	0.46	0.52	0.54	0.63	0.53	0.67	0.59	0.61	0.34	0.78	0.77	0.74	1.00	0.83	0.71	0.73	0.74	0.72	0.76	0.63	0.67	0.19	0.64	0.56	0.63	0.55	0.63	0.67	0.59	0.63
SAT_18	0.37	0.41	0.41	0.50	0.42	0.48	0.55	0.54	0.51	0.61	0.57	0.68	0.35	0.70	0.76	0.79	0.83	1.00	0.79	0.79	0.74	0.74	0.80	0.60	0.73	0.19	0.66	0.57	0.67	0.56	0.62	0.61	0.60	0.60
SAT_19	0.41	0.42	0.43	0.57	0.41	0.56	0.62	0.58	0.51	0.65	0.67	0.69	0.25	0.73	0.79	0.72	0.71	0.79	1.00	0.85	0.88	0.81	0.79	0.62	0.75	0.10	0.63	0.59	0.61	0.60	0.66	0.61	0.61	0.58
SAT_20	0.39	0.39	0.38	0.55	0.39	0.45	0.58	0.55	0.53	0.57	0.59	0.67	0.23	0.70	0.81	0.67	0.73	0.79	0.85	1.00	0.84	0.85	0.82	0.55	0.64	0.10	0.57	0.48	0.56	0.47	0.61	0.56	0.51	0.52
SAT_21	0.37	0.37	0.39	0.57	0.35	0.52	0.49	0.54	0.45	0.61	0.59	0.68	0.19	0.74	0.76	0.69	0.74	0.74	0.88	0.84	1.00	0.82	0.79	0.61	0.70	0.04	0.57	0.61	0.61	0.52	0.66	0.58	0.59	0.53
SAT_22	0.43	0.50	0.45	0.60	0.50	0.41	0.61	0.59	0.63	0.53	0.62	0.68	0.28	0.79	0.83	0.66	0.72	0.74	0.81	0.85	0.82	1.00	0.87	0.59	0.65	0.11	0.65	0.61	0.66	0.57	0.62	0.53	0.55	0.66
SAT_23	0.33	0.46	0.42	0.52	0.47	0.43	0.54	0.51	0.55	0.55	0.59	0.62	0.32	0.81	0.80	0.70	0.76	0.80	0.79	0.82	0.79	0.87	1.00	0.66	0.65	0.14	0.72	0.61	0.68	0.60	0.66	0.68	0.65	0.69
SAT_24	0.42	0.42	0.44	0.51	0.47	0.53	0.51	0.58	0.55	0.60	0.63	0.55	0.27	0.60	0.61	0.51	0.63	0.60	0.62	0.55	0.61	0.59	0.66	1.00	0.62	0.30	0.69	0.66	0.68	0.64	0.68	0.70	0.61	0.65
SAT_25	0.28	0.38	0.34	0.43	0.31	0.45	0.43	0.51	0.44	0.56	0.53	0.58	0.24	0.56	0.62	0.68	0.67	0.73	0.75	0.64	0.70	0.65	0.65	0.62	1.00	0.11	0.65	0.61	0.57	0.54	0.67	0.63	0.62	0.63
SAT_26	0.14	0.02	-0.03	0.12	0.09	0.13	0.04	0.13	0.06	0.11	0.10	0.05	0.32	0.08	0.17	0.07	0.19	0.19	0.10	0.10	0.04	0.11	0.14	0.30	0.11	1.00	0.26	0.23	0.12	0.22	0.24	0.25	0.23	0.19
SAT_27	0.41	0.45	0.40	0.44	0.37	0.40	0.49	0.44	0.51	0.51	0.54	0.54	0.24	0.60	0.58	0.54	0.64	0.66	0.63	0.57	0.57	0.65	0.72	0.69	0.65	0.26	1.00	0.78	0.74	0.67	0.66	0.65	0.61	0.80
SAT_28	0.47	0.51	0.46	0.46	0.36	0.37	0.45	0.49	0.52	0.53	0.53	0.53	0.19	0.56	0.55	0.52	0.56	0.57	0.59	0.48	0.61	0.61	0.61	0.66	0.61	0.23	0.78	1.00	0.79	0.74	0.68	0.61	0.69	0.78
SAT_29	0.49	0.56	0.51	0.56	0.47	0.44	0.53	0.50	0.57	0.47	0.54	0.61	0.26	0.69	0.62	0.57	0.63	0.67	0.61	0.56	0.61	0.66	0.68	0.68	0.57	0.12	0.74	0.79	1.00	0.79	0.70	0.69	0.71	0.78
SAT_30	0.45	0.49	0.46	0.48	0.44	0.41	0.50	0.52	0.48	0.52	0.54	0.61	0.19	0.64	0.63	0.54	0.55	0.56	0.60	0.47	0.52	0.57	0.60	0.64	0.54	0.22	0.67	0.74	0.79	1.00	0.73	0.71	0.74	0.74
SAT_31	0.30	0.29	0.38	0.44	0.34	0.48	0.45	0.48	0.42	0.56	0.56	0.59	0.20	0.63	0.64	0.60	0.63	0.62	0.66	0.61	0.66	0.62	0.66	0.68	0.67	0.24	0.66	0.68	0.70	0.73	1.00	0.78	0.76	0.68
SAT_32	0.33	0.36	0.42	0.45	0.45	0.56	0.48	0.48	0.46	0.50	0.55	0.52	0.23	0.61	0.56	0.56	0.67	0.61	0.61	0.56	0.58	0.53	0.68	0.70	0.63	0.25	0.65	0.61	0.69	0.71	0.78	1.00	0.79	0.75
SAT_33	0.37	0.34	0.39	0.39	0.29	0.37	0.39	0.38	0.40	0.46	0.51	0.51	0.24	0.53	0.51	0.56	0.59	0.60	0.61	0.51	0.59	0.55	0.65	0.61	0.62	0.23	0.61	0.69	0.71	0.74	0.76	0.79	1.00	0.73
SAT_34	0.45	0.56	0.52	0.51	0.50	0.38	0.56	0.52	0.60	0.50	0.58	0.53	0.20	0.65	0.58	0.59	0.63	0.60	0.58	0.52	0.53	0.66	0.69	0.65	0.63	0.19	0.80	0.78	0.78	0.74	0.68	0.75	0.73	1.00

D9- Anti-image Correlation Matrix of BI Satisfactory Variables (MSA)

	SAT_1	SAT_2	SAT_3	SAT_4	SAT_5	SAT_6	SAT_7	SAT_8	SAT_9	SAT_10	SAT_11	SAT_12	SAT_13	SAT_14	SAT_15	SAT_16	SAT_17	SAT_18	SAT_19	SAT_20	SAT_21	SAT_22	SAT_23	SAT_24	SAT_25	SAT_26	SAT_27	SAT_28	SAT_29	SAT_30	SAT_31	SAT_32	SAT_33	SAT_34	
SAT_1	.825*	-.559	-.391	.338	-.177	-.233	-.302	-.051	.073	.177	-.233	-.063	-.014	.021	.199	-.024	.098	-.077	.177	-.283	-.244	-.043	.334	-.015	.164	-.323	-.243	-.024	.036	-.125	.131	.220	-.343	.159	
SAT_2	-.559	.876*	-.020	-.372	-.6E-05	.244	.083	-.058	.059	-.203	.187	.014	.172	-.142	-.156	-.015	-.042	.193	-.060	.076	.280	.072	-.288	.071	-.294	.108	.168	-.116	-.217	.097	.188	-.090	.170	-.085	
SAT_3	-.391	-.020	.914*	-.300	-.144	-.139	.108	.102	-.199	-.180	.265	-.068	-.021	-.165	-.198	-.029	.186	-.079	-.032	.155	.109	.018	.012	-.038	.089	.336	.020	-.058	.107	.202	-.069	-.080	-.104	-.129	
SAT_4	.338	-.372	-.300	.897*	-.187	-.359	-.011	.069	.049	.157	-.420	-.005	-.193	.006	.113	-.167	.053	.074	.173	-.241	-.256	-.071	.213	.027	.048	-.263	-.033	.091	-.123	-.117	.074	.179	-.043	-.014	
SAT_5	-.177	-.6E-05	-.144	-.187	.935*	-.071	-.079	-.276	.147	.117	-.073	.153	-.162	.028	.086	.121	-.077	-.106	.009	.125	.134	-.120	-.209	-.038	.032	.129	.171	.008	.062	-.110	-.045	-.145	.260	-.107	
SAT_6	-.233	.244	-.139	-.359	-.071	.917*	-.189	-.025	.012	-.180	.048	-.004	.011	-.028	-.020	-.111	.013	.103	-.099	.224	-.113	.114	-.026	.072	-.134	-.090	-.114	.114	-.097	.134	-.036	-.385	.185	.267	
SAT_7	-.302	.083	-.108	-.011	-.079	-.189	.906*	-.022	-.273	-.060	.078	-.150	.128	.318	-.094	.331	-.193	-.119	-.419	.098	.227	-.066	-.123	-.011	.202	.228	.161	.118	-.031	.006	-.147	.026	.170	-.313	
SAT_8	-.051	-.058	-.102	.069	-.276	-.025	-.022	.953*	-.319	-.258	-.123	-.043	.086	.004	-.252	-.172	-.089	.169	.095	.015	-.050	-.014	.147	-.069	-.177	-.142	.161	.012	-.049	-.044	.057	-.024	.109	.023	
SAT_9	.073	.059	-.199	.049	.147	.012	-.273	-.319	.899*	-.381	.007	.008	-.083	-.131	.110	-.138	.288	.052	.198	-.095	.265	-.449	.092	-.036	.008	.002	-.005	-.071	-.288	.233	.326	-.231	-.063	.009	
SAT_10	.177	-.203	-.180	.157	.117	-.180	-.060	-.258	-.381	.843*	-.506	.168	.020	.050	.227	.175	-.420	-.159	-.011	-.153	-.292	.490	-.186	.007	-.041	-.035	-.018	-.143	.423	-.431	-.340	.441	.053	.052	
SAT_11	-.233	.187	.265	-.420	-.073	.048	.078	-.123	.007	-.506	.908*	-.190	.077	.067	-.138	.145	.155	-.020	-.288	.211	.260	-.189	-.012	-.140	.158	.229	-.016	.079	-.042	.289	-.009	-.168	-.143	-.130	
SAT_12	-.063	.014	-.068	-.005	.153	-.004	-.150	-.043	.008	.168	-.190	.973*	.028	-.077	-.128	-.100	.031	-.145	.128	-.060	-.129	.007	.094	-.002	-.078	.074	-.062	.001	.050	-.202	-.038	.002	.036	.107	
SAT_13	-.014	.172	-.021	-.193	-.162	.011	.128	.086	-.083	.020	.077	.028	.806*	.198	-.211	.039	-.212	-.004	-.163	.126	.178	.003	-.133	-.043	-.052	-.164	.070	-.029	-.121	.063	.047	.065	-.054	.052	
SAT_14	.021	-.142	-.165	.006	.028	-.028	.318	.004	-.131	.050	.067	-.077	.198	.925*	-.039	.191	-.417	-.028	-.319	.234	-.059	-.089	-.268	-.009	.224	.015	.174	.200	-.106	-.186	-.211	.042	.271	-.182	
SAT_15	.199	-.156	-.198	.113	.086	-.020	-.094	-.252	.110	.227	-.138	-.128	-.211	-.039	.948*	-.172	-.194	.036	-.054	-.247	.017	-.099	-.111	-.060	.069	-.118	.060	-.043	.103	-.318	-.133	.127	.143	.114	
SAT_16	-.024	-.015	-.029	-.167	.121	-.111	.331	-.172	-.138	.175	.145	-.100	.039	.191	-.172	.912*	-.239	-.373	-.278	.127	.018	.154	-.171	.010	.047	.222	.150	.039	.165	-.063	-.218	.160	.028	-.328	
SAT_17	.098	-.042	.186	.053	-.077	.013	-.193	-.089	.288	-.420	.155	.031	-.212	-.417	-.194	-.239	.891*	-.261	.341	-.018	-.131	-.235	.345	.007	.057	-.003	-.269	.081	-.090	.328	.285	-.330	-.247	.010	
SAT_18	-.077	.193	-.079	.074	-.106	.103	-.119	.169	.052	-.159	-.020	-.145	-.004	-.028	.036	-.373	-.261	.929*	-.043	-.245	.159	.094	-.216	.110	-.370	-.265	.046	-.019	-.379	.053	.182	.053	.023	.177	
SAT_19	.177	-.060	-.032	.173	.009	-.099	-.419	.095	.198	-.011	-.288	.128	-.163	-.319	-.054	-.278	.341	-.043	.911*	-.333	-.401	.013	.143	.071	-.304	-.137	-.164	-.024	.045	-.137	.256	.017	-.172	.145	
SAT_20	-.283	.076	.155	-.241	.125	.224	.098	.015	-.095	-.153	.211	-.060	.126	.234	-.247	.127	-.018	-.245	-.333	.921*	-.074	-.250	-.113	.044	.172	.120	-.001	.215	.004	.222	-.191	-.287	.170	-.032	
SAT_21	-.244	.280	.109	-.256	.134	-.113	.227	-.050	.265	-.292	.260	-.129	.178	-.059	.017	.018	-.131	.159	-.401	-.074	.902*	-.357	-.137	-.148	-.020	.268	.260	-.339	-.151	.263	.058	-.136	-.009	.072	
SAT_22	-.043	.072	.018	-.071	-.120	.114	-.066	-.014	-.449	.490	-.189	.007	.003	-.089	-.099	.154	-.235	.094	.013	-.250	-.357	.900*	-.425	.115	-.261	-.118	.046	-.050	.161	-.221	-.209	.466	.056	-.142	
SAT_23	.334	-.288	.012	.213	-.209	-.026	-.123	.147	.092	-.186	-.012	.094	-.133	-.268	-.111	-.171	.345	-.216	.143	-.113	-.137	-.425	.902*	-.112	.251	.015	-.420	.094	.034	.183	.190	-.253	-.346	.144	
SAT_24	-.015	.071	-.038	.027	-.038	.072	-.011	-.069	-.036	.007	-.140	-.002	-.043	-.009	-.060	.010	.007	.110	.071	.044	-.148	.115	-.112	.977*	-.169	-.212	-.157	-.003	-.160	-.004	-.029	-.121	.062	.086	
SAT_25	.164	-.294	.089	.048	.032	-.134	.202	-.177	.008	-.041	.158	-.078	-.052	.224	.069	.047	.057	-.370	-.304	.172	-.020	-.261	.251	-.169	.917*	.223	.466*	-.028	-.152	.292	.044	-.147	-.134	-.021	-.096
SAT_26	-.323	.108	.336	-.263	.129	-.090	.228	-.142	.002	-.035	.229	.074	-.164	.015	-.118	.222	-.003	-.265	-.137	.120	.268	-.118	.015	-.212	.223	.466*	-.028	-.152	.292	.044	-.147	-.134	-.021	-.096	
SAT_27	-.243	.168	.020	-.033	.171	-.114	.161	.161	-.005	-.018	-.016	-.062	.070	.174	.060	.150	-.269	.046	-.164	-.001	.260	.046	-.420	-.157	-.179	-.028	.912*	-.256	-.133	-.095	-.093	.096	.369	-.385	
SAT_28	-.024	-.116	-.058	.091	.008	.114	.118	.012	-.071	-.143	.079	.001	-.029	.200	-.043	.039	.081	-.019	-.024	.215	-.339	-.050	.094	-.003	.040	-.152	-.256	.951*	-.251	-.082	-.082	.048	-.021	-.247	
SAT_29	.036	-.217	.107	-.123	.062	-.097	-.031	-.049	-.288	.423	-.042	.050	-.121	-.106	.103	.165	-.090	-.379	.045	.004	-.151	.161	.034	-.160	.179	.292	-.133	-.251	.919*	-.346	-.268	.117	-.090	-.036	
SAT_30	-.125	.097	.202	-.117	-.110	.134	.006	-.044	.233	-.431	.289	-.202	.063	-.186	-.318	-.063	.328	.053	-.137	.222	.263	-.221	.183	-.004	.124	.044	-.095	-.082	-.346	.894*	.057	-.307	-.270	-.024	
SAT_31	.131	.188	-.069	.074	-.045	-.036	-.147	.057	.326	-.340	-.009	-.038	.047	-.211	-.133	-.218	.285	.182	.256	-.191	.058	-.209	.190	-.029	-.175	-.147	-.093	-.082	-.268	.057	.916*	-.280	-.259	.098	
SAT_32	.220	-.090	-.080	.179	-.145	-.385	.026	-.024	-.231	.441	-.168	.002	.065	.042	.127	.160	-.330	.053	.017	-.287	-.136	.466	-.253	-.121	-.113	-.134	.096	.048	.117	-.307	-.280	.881*	-.241	-.279	
SAT_33	-.343	.170	-.104	-.043	.260	.185	.170	.109	-.063	.053	-.143	.036	-.054	.271	.143	.028	-.247	.023	-.172	.170	-.009	.056	-.346	.062	-.119	-.021	.369	-.021	-.090	-.270	-.259	-.241	.902*	-.184	
SAT_34	.159	-.085	-.129	-.014	-.107	.267	-.313	.023	.009	.052	-.130	.107	.052	-.182	.114	-.328	.010	.177	.145	-.032	.072	-.142	.144	.086	-.142	-.096	-.385	-.247	-.036	-.024	.098	-.279	-.184	.930*	

APPENDICES

D10- Total Variance of Observed BI Satisfactory Variables

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	19.156	56.342	56.342	19.156	56.342	56.342	9.065	26.663	26.663
2	3.146	9.252	65.594	3.146	9.252	65.594	7.854	23.100	49.763
3	1.821	5.355	70.950	1.821	5.355	70.950	6.717	19.757	69.520
4	1.289	3.791	74.741	1.289	3.791	74.741	1.524	4.483	74.003
5	1.069	3.144	77.885	1.069	3.144	77.885	1.320	3.883	77.885
6	.786	2.311	80.196						
7	.673	1.979	82.176						
8	.601	1.767	83.943						
9	.555	1.632	85.574						
10	.519	1.527	87.101						
11	.464	1.364	88.464						
12	.396	1.165	89.629						
13	.369	1.084	90.713						
14	.321	.945	91.659						
15	.305	.897	92.556						
16	.264	.777	93.333						
17	.252	.740	94.073						
18	.243	.715	94.788						
19	.229	.674	95.462						
20	.210	.618	96.080						
21	.201	.591	96.671						
22	.166	.488	97.159						
23	.144	.425	97.583						
24	.143	.420	98.003						
25	.126	.371	98.374						
26	.116	.340	98.714						
27	.083	.244	98.959						
28	.073	.216	99.175						
29	.067	.196	99.371						
30	.064	.188	99.559						
31	.051	.150	99.708						
32	.046	.134	99.843						
33	.030	.088	99.931						
34	.023	.069	100.000						

APPENDICES

D11- Varimax Rotated Components Matrix for BI Satisfactory Measures

Business Intelligence Dimension	Component Matrix ^a					Cronbach's Alpha if Item Deleted	Variable Code	Business Intelligence Characteristics	
		1	2	3	4				5
Business Intelligence	BI_AnalFramework_S	.803	-.119	.374	-.144	.144	0.975	SAT_34	Business Intelligence Analytical Framework
	BI_DataArchitecture_S	.727	-.310	.355	-.085	-.107	0.974	SAT_33	Business Intelligence Data Architecture
	BI_Datawarehouse_S	.769	-.223	.301	.024	-.183	0.974	SAT_32	Enterprise Data Warehouse
	BI_UserSupport_S	.775	-.307	.210	-.055	-.239	0.974	SAT_31	Business Intelligence Users Support
Business and Technology Alignment	BTAaccess_S	.649	.497	.040	.184	.201	0.974	SAT_5	Access to data and reports via the internet
	BTAalign_S	.620	.583	.163	-.025	.086	0.974	SAT_1	Technology and Business alignment
	BTAdecisions_S	.684	.399	-.052	.184	-.312	0.975	SAT_6	Top decision areas are addressed and prioritised in the information system
	BTAquality_S	.669	.546	.088	-.075	.163	0.974	SAT_3	Quality of Technical support
	BTArepaccess_S	.777	.411	-.102	.089	-.162	0.974	SAT_8	Access of data and reports from a single area
	BTAerrors_S	.739	.372	-.071	.143	.133	0.976	SAT_4	Frequency of System Errors
	BTAstystem_S	.658	.473	.106	-.143	.335	0.975	SAT_2	Business Intelligence System Response time
	BTAtools_S	.750	.425	-.069	-.015	-.091	0.974	SAT_7	Business intelligence tools to support decision making processes
	BTAwork_S	.748	.427	.004	-.022	-.002	0.974	SAT_9	IT and University core business teams working together
	Organizational and Behavioural Strategies	OBSadopt_S	.770	-.029	-.170	-.118	-.006	0.974	SAT_12
OBSdatagov_S		.743	-.300	-.226	-.007	.095	0.975	SAT_16	Data governance alignment
OBSdesign_S		.822	-.120	-.159	-.094	.191	0.975	SAT_14	Organizational design approaches for business intelligence tools
OBSemc_S		.808	.342	-.041	.042	-.255	0.974	SAT_11	Executive management support
OBSgovernance_S		.838	-.168	-.276	.096	.141	0.975	SAT_15	IT governance alignment
OBSictprovision_S		.854	-.191	-.279	-.032	-.103	0.975	SAT_19	Provision of ICT accessibility
OBSpolitics_S		.775	.294	-.095	.025	-.380	0.975	SAT_10	Understanding the institutional culture and politics that exist and obstacles to look for change
OBSskills_S		.297	-.214	.001	.710	.353	0.975	SAT_13	Business intelligence competency and skills
OBSstandards_S		.830	-.255	-.211	.090	.020	0.975	SAT_18	Creating technology standards
Technology Strategies	OBSstratalign_S	.829	-.208	-.175	.121	-.025	0.975	SAT_17	Business Strategy alignment
	TSadopten_S	.780	-.099	.219	.111	-.164	0.976	SAT_24	User adoption enablement
	TSassess_S	.815	-.240	-.318	-.106	-.089	0.974	SAT_21	Assessment of current BI/IT and business relationship
	TSBIStandards_S	.813	-.129	.300	-.157	.215	0.975	SAT_29	Business Intelligence Standards and Frameworks
	TScomms_S	.850	-.154	-.251	-.038	.206	0.975	SAT_22	Communication Plan to various stakeholders for BI/IT implementations
	TSHETDATAACC_S	.768	-.132	.385	-.127	.039	0.974	SAT_30	Business Intelligence data quality
	TSmethods_S	.189	-.168	.379	.688	-.129	0.974	SAT_26	Methodological processes for BI implementations
	TSplan_S	.851	-.272	-.152	-.008	.146	0.975	SAT_23	Organizational Plan to establish a business case for BI investment
	TSrelations_S	.803	-.196	-.392	-.005	-.006	0.974	SAT_20	Relationship between BI/IT and core business of the institution
	TSrepstandards_S	.773	-.228	.284	-.057	.054	0.974	SAT_27	Business intelligence standards
	TStraining_S	.755	-.288	-.062	-.058	-.170	0.974	SAT_25	Training plan for the users
	TSvarusers_S	.760	-.157	.387	-.163	.061	0.974	SAT_28	Support of a broad range of users
	Cronbach	.980	.970	.970	.970	.970			
Extraction Method: Principal Component Analysis, 5 components extracted using Varimax Rotation.									

APPENDICES

D12- Correlation Matrix for the BI Importance Measures

	IMP_1	IMP_2	IMP_3	IMP_4	IMP_5	IMP_6	IMP_7	IMP_8	IMP_9	IMP_10	IMP_11	IMP_12	IMP_13	IMP_14	IMP_15	IMP_16	IMP_17	IMP_18	IMP_19	IMP_20	IMP_21	IMP_22	IMP_23	IMP_24	IMP_25	IMP_26	IMP_27	IMP_28	IMP_29	IMP_30	IMP_31	IMP_32	IMP_33	IMP_34
IMP_1	1.000	.321	.350	.252	.024	.331	.311	.407	.199	.244	.109	.231	.095	.047	.037	.184	-.097	.184	.244	.184	.069	.063	.087	.106	.168	.293	.170	.106	.081	-.018	.162	.058	.093	.037
IMP_2	.321	1.000	.350	.353	.407	.331	.502	.598	.572	.419	.354	-.006	.321	.216	.233	.184	.170	.184	.157	.184	-.018	.273	.087	.293	.273	.386	.081	.013	.081	.069	.152	.058	.093	.037
IMP_3	.350	.350	1.000	.386	.443	.642	.343	.243	.227	.276	.308	.131	.231	.159	-.048	.116	.011	.021	.276	.116	.276	.191	.032	.129	.301	.129	.104	.129	.104	.093	.071	.082	-.074	-.048
IMP_4	.252	.353	.386	1.000	.576	.558	.319	.490	.299	.245	.405	-.038	.151	.062	.166	.361	.102	.361	.479	.280	.245	.298	.159	.215	.298	.048	.262	.048	.262	-.068	.158	.152	.361	.078
IMP_5	.024	.407	.443	.576	1.000	.494	.354	.354	.331	.346	.345	.143	.120	.309	.212	.157	.366	.387	.198	.157	.272	.257	.178	.016	.257	.174	.065	.085	.366	.198	.095	.037	.234	.129
IMP_6	.331	.331	.642	.558	.494	1.000	.494	.494	.394	.257	.311	.001	.157	.219	.297	.369	.277	.228	.460	.299	.460	.352	.215	.322	.352	.250	.346	.178	.139	.189	.284	.304	.299	.145
IMP_7	.311	.502	.343	.319	.354	.494	1.000	.758	.489	.568	.415	.143	.120	.167	.212	.387	.291	.234	.272	.157	.346	.169	.178	.253	.257	.174	.215	.174	.065	.125	.309	.182	.310	.461
IMP_8	.407	.598	.243	.490	.354	.494	.758	1.000	.489	.494	.345	.043	.120	.095	.295	.387	.215	.310	.346	.157	.272	.257	.178	.253	.169	.331	.291	.095	.065	.125	.238	.182	.310	.295
IMP_9	.199	.572	.227	.299	.331	.394	.489	.489	1.000	.466	.454	-.066	.199	.285	.356	.288	.195	.213	.322	.288	.178	.239	.220	.309	.239	.309	.195	.079	.121	.106	.285	.232	.138	.356
IMP_10	.244	.419	.276	.245	.346	.257	.568	.494	.466	1.000	.565	.093	.244	.284	.069	.299	.208	.228	.324	.158	.324	.190	.276	.106	.109	.178	.277	.322	.277	.257	.219	.171	.088	.373
IMP_11	.109	.354	.308	.405	.345	.311	.415	.345	.454	.565	1.000	.223	.027	.085	.018	.228	.077	.096	.311	.162	.375	.212	.182	.049	.212	-.019	.206	.251	.270	.185	.146	.227	.096	.445
IMP_12	.231	-.006	.131	-.038	.143	.001	.143	.043	-.066	.093	.223	1.000	-.006	.248	.158	.212	.198	.021	.093	.116	.184	.082	.116	.129	-.028	.032	.198	.129	.384	.184	-.017	-.008	.021	.055
IMP_13	.095	.321	.231	.151	.120	.157	.120	.120	.199	.244	.027	-.006	1.000	.385	.331	.093	.081	.184	.157	.093	.069	.377	.167	.572	.168	.386	.259	.293	.348	-.018	.216	.230	.093	-.062
IMP_14	.047	.216	.159	.062	.309	.219	.167	.095	.285	.284	.085	.248	.385	1.000	.556	.398	.639	.330	.284	.465	.350	.318	.232	.424	.084	.285	.373	.285	.306	.284	.307	.328	.330	.116
IMP_15	.037	.233	-.048	.166	.212	.297	.212	.295	.356	.069	.018	.158	.331	.556	1.000	.414	.470	.414	.221	.335	.221	.459	.342	.518	.095	.518	.470	.032	.238	.221	.336	.354	.414	.062
IMP_16	.184	.184	.116	.361	.157	.369	.387	.387	.288	.299	.228	.212	.093	.398	.414	1.000	.391	.340	.299	.340	.510	.221	.197	.288	.137	.213	.391	.063	.247	.158	.262	.211	.267	.256
IMP_17	-.097	.170	.011	.102	.366	.277	.291	.215	.195	.208	.077	.198	.081	.639	.470	.391	1.000	.606	.208	.462	.484	.205	.300	.268	-.042	.121	.297	.195	.227	.277	.107	.190	.247	.238
IMP_18	.184	.184	.021	.361	.387	.228	.234	.310	.213	.228	.096	.021	.184	.330	.414	.340	.606	1.000	.299	.267	.299	.221	.390	.138	.137	.138	.175	-.012	.247	.017	.194	.072	.194	.097
IMP_19	.244	.157	.276	.479	.198	.460	.272	.346	.322	.324	.311	.093	.157	.284	.221	.299	.208	.299	1.000	.510	.257	.352	.461	.322	.190	.178	.346	.250	.139	.054	.284	.238	.369	.145
IMP_20	.184	.184	.116	.280	.157	.299	.157	.157	.288	.158	.162	.116	.093	.465	.335	.340	.462	.267	.510	1.000	.369	.306	.197	.363	.137	.138	.319	.138	.103	.158	.126	.072	.340	.097
IMP_21	.069	-.018	.276	.245	.272	.460	.346	.272	.178	.324	.375	.184	.069	.350	.221	.510	.484	.299	.257	.369	1.000	.433	.338	.106	.109	.106	.277	.250	.208	.257	.219	.238	.228	.373
IMP_22	.063	.273	.191	.298	.257	.352	.169	.257	.239	.180	.212	.082	.377	.318	.459	.221	.205	.221	.352	.306	.433	1.000	.333	.239	.322	.325	.288	.152	.370	.109	.318	.175	.221	-.087
IMP_23	.087	.087	.032	.159	.178	.215	.178	.178	.220	.276	.182	.116	.167	.232	.342	.197	.300	.390	.461	.197	.338	.333	1.000	.155	.038	.286	.174	.220	.174	-.032	.232	.133	.197	.273
IMP_24	.106	.293	.129	.215	.016	.322	.253	.253	.309	.106	.049	.129	.572	.424	.518	.288	.268	.188	.322	.363	.106	.239	.155	1.000	.152	.309	.415	.232	.195	.106	.354	.515	.363	.032
IMP_25	.168	.273	.301	.298	.257	.352	.257	.169	.239	.109	.212	-.028	.168	.084	.095	.137	-.042	.137	.190	.137	.109	.322	.038	.152	1.000	.066	-.042	.066	.370	.271	.474	.255	.306	.004
IMP_26	.293	.386	.129	.048	.174	.250	.174	.331	.309	.178	-.019	.032	.386	.285	.518	.213	.121	.198	.178	.138	.106	.325	.286	.309	.066	1.000	.415	.309	.121	.250	.215	.232	.288	.032
IMP_27	.170	.081	.104	.262	.065	.346	.215	.291	.195	.277	.206	.198	.259	.373	.470	.391	.297	.175	.346	.319	.277	.288	.174	.415	-.042	.415	1.000	.489	.297	.346	.240	.326	.391	.238
IMP_28	.106	.013	.129	.048	.095	.178	.174	.095	.079	.322	.251	.129	.293	.285	.032	.063	.195	-.012	.250	.138	.250	.152	.220	.232	.066	.309	.489	1.000	.342	.178	.215	.232	.213	.437
IMP_29	.081	.081	.104	.262	.366	.139	.065	.065	.121	.277	.270	.384	.348	.306	.238	.247	.227	.247	.139	.103	.208	.370	.174	.165	.370	.121	.297	.342	1.000	.346	.240	.180	.103	.083
IMP_30	-.018	.069	.093	-.068	.198	.189	.125	.125	.106	.257	.185	.184	-.018	.284	.221	.158	.277	.017	.054	.158	.257	.109	-.032	.106	.271	.250	.346	.178	.346	1.000	.350	.238	.299	.145
IMP_31	.132	.132	.071	.138	.095	.284	.309	.238	.285	.219	.146	-.017	.216	.307	.336	.262	.107	.194	.284	.126	.219	.318	.232	.354	.474	.215	.240	.215	.240	.350	1.000	.584	.601	.116
IMP_32	.058	.058	.082	.152	.037	.304	.182	.182	.232	.171	.227	-.008	.230	.328	.354	.211	.190	.072	.238	.072	.238	.175	.133	.515	.255	.232	.326	.232	.190	.238	.584	1.000	.556	.205
IMP_33	.093	.093	-.074	.361	.234	.299	.310	.310	.138	.088	.096	.021	.093	.330	.414	.267	.247	.194	.369	.340	.228	.221	.197	.363	.306	.288	.391	.213	.103	.299	.601	.556	1.000	.256
IMP_34	.037	.037	-.048	.078	.129	.145	.461	.295	.356	.373	.445	.055	-.062	.116	.062	.256	.238	.097	.145	.097	.373	-.087	.273	.032	.004	.032	.238	.437	.083	.145	.116	.205	.256	1.000

APPENDICES

D13- Anti-image Correlation Matrix of BI Importance Components (MSA)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1 BTAlign_I	.387 ^a	-.245	-.108	-.224	.516	-.415	-.072	-.087	-.001	-.144	.312	-.498	.184	-.275	.166	.196	.438	-.508	.215	-.325	.034	.086	.037	.208	.152	-.245	.168	-.085	-.166	-.002	.019	-.135	-.005	-.106
2 BTASystem_I	-.245	.643 ^a	-.151	-.026	-.121	.157	.079	-.371	-.183	-.059	-.440	.145	-.172	-.010	.204	-.114	-.420	.263	.255	.018	.454	-.241	-.067	-.206	-.218	-.273	.070	.182	.184	.072	-.058	.218	-.020	.076
3 BTAQuality_I	-.108	-.151	.651 ^a	-.175	-.216	-.345	-.289	.254	.134	.099	.051	-.152	-.173	-.215	.119	.135	.176	.057	-.149	-.028	-.199	.133	.016	.105	-.134	-.041	-.120	-.006	.234	-.128	-.032	-.191	.450	.113
4 BTAsyerrors_I	-.224	-.026	-.175	.653 ^a	-.502	.070	.245	-.272	-.011	.137	-.284	.377	-.041	.277	-.019	-.377	.054	-.033	-.219	.040	-.041	-.003	-.007	-.186	-.033	.353	-.249	.012	-.179	.264	.200	.091	-.386	.171
5 BTAaccess_I	.516	-.121	-.216	-.502	.581 ^a	-.407	-.036	.047	-.110	-.238	.137	-.355	.179	-.316	.058	.347	.065	-.311	.282	-.010	.077	.010	.068	.202	.182	-.295	.402	-.019	-.284	-.071	.048	.120	-.204	-.112
6 BTAdecisions_I	-.415	.157	-.345	.070	-.407	.742 ^a	-.040	-.071	-.083	.204	-.085	.382	-.016	.300	-.195	-.165	-.284	.336	-.254	.158	-.172	-.008	-.061	-.161	-.202	.142	-.240	-.009	.130	-.002	-.019	-.016	.047	.126
7 BTAtools_I	-.072	.079	-.289	.245	-.036	-.040	.713 ^a	-.515	-.026	-.389	-.118	-.071	-.025	.234	-.052	-.070	-.348	.199	.032	.185	.031	.017	.154	-.197	-.250	.037	-.012	.151	.056	.356	-.207	.355	-.280	-.279
8 BTArepaccess_I	-.087	-.371	.254	-.272	.047	-.071	-.515	.808 ^a	.000	-.062	.221	-.043	.115	.074	-.110	.055	.130	-.120	-.185	.128	-.179	-.042	.124	.031	.174	-.055	.005	-.049	.044	-.184	.062	-.119	.096	-.011
9 BTAwork_I	-.001	-.183	.134	-.011	-.110	-.083	-.026	.000	.786 ^a	-.104	-.151	.158	.115	-.131	-.121	.138	.018	.097	-.153	-.139	.003	.087	.122	-.120	-.094	-.229	-.073	.287	-.057	.179	-.298	.014	.351	-.376
10 OBSpolitics_I	-.144	-.059	.099	.137	-.238	.204	-.389	-.062	-.104	.743 ^a	-.212	.226	-.216	-.136	.157	-.189	.177	-.063	-.116	-.087	-.024	.023	-.263	.167	.189	.189	-.136	-.150	-.026	-.304	.095	-.225	.164	.192
11 OBSemc_I	.312	-.440	.051	-.284	.137	-.085	-.118	.221	-.151	-.212	.640 ^a	-.408	.117	.023	-.078	.128	.354	-.225	-.050	-.148	-.233	.000	.019	.235	.095	.179	.030	-.205	.013	-.197	.095	-.362	.163	-.193
12 OBSadopt_I	-.498	.145	-.152	.377	-.355	.382	-.071	-.043	.158	.226	-.408	.303 ^a	.105	.060	-.135	-.186	-.189	.302	-.207	.194	-.079	.041	-.089	-.298	.006	.128	-.169	.106	-.292	.089	.065	.210	-.105	.163
13 OBSskills_I	.184	-.172	-.173	-.041	.179	-.016	-.025	.115	.115	-.216	.117	.105	.641 ^a	-.287	.023	.211	.230	-.255	.055	.134	-.120	-.121	.099	-.485	.058	-.225	.046	-.017	-.324	.178	.026	.137	-.037	-.083
14 OBSdesign_I	-.275	-.010	-.215	.277	-.316	.300	.234	.074	-.131	-.136	.023	.060	-.287	.728 ^a	-.339	-.300	-.406	.266	-.196	-.006	-.031	.005	.100	.020	-.042	.241	-.057	-.115	.101	.072	-.073	-.018	-.161	.077
15 OBSgovernance_I	.166	.204	.119	-.019	.058	-.195	-.052	-.110	-.121	.157	-.078	-.135	.023	-.339	.772 ^a	-.066	.001	-.205	.291	-.080	.291	-.340	-.190	-.186	.048	-.350	-.160	.304	.004	-.027	-.005	-.033	-.022	-.080
16 OBSdatagov_I	.196	-.114	.135	-.377	.347	-.165	-.070	.055	.138	-.189	.128	-.186	.211	-.300	-.066	.677 ^a	.004	-.013	-.051	.025	-.360	.266	.206	-.022	-.095	-.334	-.088	.297	-.210	.194	-.235	.142	.179	-.207
17 OBSstratalign_I	.438	-.420	.176	.054	.065	-.284	-.348	.130	.018	.177	.354	-.189	.230	-.406	.001	.004	.539 ^a	-.702	.107	-.348	-.197	.038	-.127	.106	.343	.223	.096	-.343	-.095	-.335	.334	-.363	.064	.075
18 OBSstandards_I	-.508	.263	.057	-.033	-.311	.336	.199	-.120	.097	-.063	-.225	.302	-.255	.266	-.205	-.013	-.702	.506 ^a	-.241	.233	-.056	.168	-.038	-.030	-.346	-.044	-.204	.310	.053	.292	-.314	.249	.120	-.002
19 OBSictprovision_I	.215	.255	-.149	-.219	.282	-.254	.032	-.185	-.153	-.116	-.050	-.207	.055	-.196	.291	-.051	.107	-.241	.700 ^a	-.365	.391	-.259	-.377	-.003	.100	-.069	.136	-.111	.088	-.097	.055	-.052	-.129	.038
20 TSrelations_I	-.325	.018	-.028	.040	-.010	.158	.185	.128	-.139	-.087	-.148	.194	.134	-.006	-.080	.025	-.348	.233	-.365	.659 ^a	-.240	-.022	.174	-.342	-.193	.015	-.082	.112	.012	.116	.062	.434	-.264	.041
21 TSassess_I	.034	.454	-.199	-.041	.077	-.172	.031	-.179	.003	-.024	-.233	-.079	-.120	-.031	.291	-.360	-.197	-.056	.391	-.240	.677 ^a	-.524	-.197	.060	.110	-.090	.194	.000	.170	-.158	.002	-.078	-.031	-.169
22 TScomms_I	.086	-.241	.133	-.003	.010	-.008	.017	-.042	.087	.023	.000	.041	-.121	.005	-.340	.266	.038	.168	-.259	-.022	-.524	.720 ^a	.004	.183	-.193	-.028	-.154	.035	-.228	.225	-.157	.082	.082	.220
23 TSplan_I	.037	-.067	.016	-.007	.068	-.061	.154	.124	.122	-.263	.019	-.089	.099	.100	-.190	.206	-.127	-.038	-.377	.174	-.197	.004	.672 ^a	-.074	-.014	-.262	.100	.115	-.097	.294	-.229	.197	.007	-.286
24 TSadopten_I	.208	-.206	.105	-.186	.202	-.161	-.197	.031	-.120	.167	.235	-.298	-.485	.020	-.186	-.022	.106	-.030	-.003	-.342	.060	.183	-.074	.690 ^a	.114	.156	.030	-.212	.066	-.161	.025	-.455	.109	.123
25 TSstraining_I	.152	-.218	-.134	-.033	.182	-.202	-.250	.174	-.094	.189	.095	.006	.058	-.042	.048	-.095	.343	-.346	.100	-.193	.110	-.193	-.014	.114	.581 ^a	.125	.370	-.203	-.312	-.329	.006	-.154	-.166	.041
26 TSmethods_I	-.245	-.273	-.041	.353	-.295	.142	.037	-.055	-.229	.189	.179	.128	-.225	.241	-.350	-.334	.223	-.044	-.069	.015	-.090	-.028	.262	.156	.125	.560 ^a	-.095	-.463	.147	-.296	.317	-.210	-.190	.291
27 TSrepstandards_I	.168	.070	-.120	-.249	.402	-.240	-.012	.005	-.073	-.136	.030	-.169	.046	-.057	-.160	-.088	.096	-.204	.136	-.082	.194	-.154	.100	.030	.370	-.095	.739 ^a	-.374	-.086	-.299	.132	-.012	-.180	-.011
28 TSvarusers_I	-.085	.182	-.006	.012	-.019	-.009	.151	-.049	.287	-.150	-.205	.106	-.017	-.115	.304	.297	-.343	.310	-.111	.112	.000	.035	.115	-.212	-.203	-.463	-.374	.486 ^a	-.220	.384	-.337	.267	.078	-.445
29 TSBIStandards_I	-.166	.184	.234	-.179	-.284	.130	.056	.044	-.057	-.026	.013	-.292	-.324	.101	.004	-.210	-.095	.053	.088	.012	.170	-.228	-.097	.066	-.312	.147	-.086	-.220	.655 ^a	-.292	-.018	-.179	.284	.028
30 TSHETDATAACC_I	-.002	.072	-.128	.264	-.071	-.002	.356	-.184	.179	-.304	-.197	.089	.178	.072	-.027	.194	-.335	.292	-.097	.116	-.158	.225	.294	-.161	-.329	-.296	-.299	.384	-.292	.437 ^a	-.335	.330	-.136	-.145
31 BI_UserSupport_I	.019	-.058	-.032	.200	.048	-.019	-.207	.062	-.298	.095	.095	.065	.026	-.073	-.005	-.235	.334	-.314	.055	.062	.002	-.157	-.229	.025	.006	.317	.132	-.337	-.018	-.335	.668 ^a	-.303	-.391	.323
32 BI_Datawarehouse_I	-.135	.218	-.191	.091	.120	-.016	.355	-.119	.014	-.225	-.362	.210	.137	-.018	-.033	.142	-.363	.249	-.052	.434	-.078	.082	.197	-.455	-.154	-.210	-.012	.267	-.179	.330	-.303	.565 ^a	-.363	-.112
33 BI_DataArchitecture_I	-.005	-.020	.450	-.386	-.204	.047	-.280	.096	.351	.164	.163	-.105	-.037	-.161	-.022	.179	.064	.120	-.129	-.264	-.031	.082	.007	.109	-.166	-.190	-.180	.078	.284	-.136	-.391	-.363	.662 ^a	-.212
34 BI_AnalFramework_I	-.106	.076	.113	.171	-.112	.126	-.279	-.011	-.376	.192	-.193	.163	-.083	.077	-.080	-.207	.075	-.002	.038	.041	-.169	.220	-.286	.123	.041	.291	-.011	-.445	.028	-.145	.323	-.112	-.212	.591 ^a

APPENDICES

D14- Rotated Component Matrix of BI Importance Components

Business Intelligence Dimension	Rotated Component Matrix ^a												Cronbach's Alpha if Item Deleted	Business Intelligence Characteristics
	Variables	Component												
		1	2	3	4	5	6	7	8	9	10	11		
Business Intelligence	BI_AnalFramework_I	.553	.127	.130	-.191	-.259	.541	.006	-.037	.076	-.142	-.091	.912	Business Intelligence Analytical Framework
	BI_DataArchitecture_I	.023	.245	.753	-.046	-.022	.208	.287	-.090	.023	.109	.107	.910	Business Intelligence Data Architecture
	BI_Datawarehouse_I	.110	.150	.726	.012	.229	.245	-.018	-.023	-.032	-.011	-.039	.911	Enterprise Data Warehouse
	BI_UserSupport_I	.166	.064	.821	.017	.069	-.019	-.047	.111	.207	.103	.023	.910	Business Intelligence Users Support
Business and Technology Alignment	BTAccess_I	.318	.160	-.019	.399	-.033	-.019	.627	.271	.017	.142	-.252	.910	Access to data and reports via the internet
	BTAlign_I	.228	-.064	.009	.193	.027	-.013	.033	.091	.073	.159	.775	.908	Technology and Business alignment
	BTAdecisions_I	.248	.244	.252	.680	-.003	.118	.307	-.121	.089	.108	.167	.908	Top decision areas are addressed and prioritised in the information system
	BTQuality_I	.224	.004	-.074	.842	.115	.028	.077	.087	-.023	.004	.139	.908	Quality of Technical support
	BTArepaccess_I	.659	.107	.157	.098	-.026	.031	.351	-.111	.015	.253	.357	.909	Access of data and reports from a single area
	BTAsyserrors_I	.201	.054	.173	.362	.122	.049	.753	-.016	.106	-.197	.212	.909	Frequency of System Errors
	BTAsystem_I	.665	.037	-.020	.215	.359	-.256	.168	.001	-.047	.278	.110	.910	Business Intelligence System Response time
	BTAtools_I	.755	.170	.185	.132	-.080	.073	.164	-.028	-.031	.079	.220	.913	Business intelligence tools to support decision making processes
	BTAsystem_I	.728	.188	.156	.109	.244	-.087	.018	-.110	.133	.061	-.013	.911	IT and University core business teams working together
Organizational and Behavioural Strategies	OBSadopt_I	.009	.293	-.129	-.037	-.046	.105	-.098	.667	-.075	-.063	.414	.909	User adoption of the business intelligence technology
	OBSdatagov_I	.256	.560	.191	.015	-.063	.047	.151	.110	.071	-.001	.301	.909	Data governance alignment
	OBSdesign_I	.104	.704	.141	.077	.326	.104	-.040	.224	.072	.154	.138	.909	Organizational design approaches for business intelligence tools
	OBSemc_I	.632	.018	.088	.229	-.046	.228	.063	.256	.139	-.332	-.009	.910	Executive management support
	OBSgovernance_I	.061	.557	.295	-.136	.289	-.041	.165	.041	.173	.452	.051	.910	IT governance alignment
	OBSictprovision_I	.132	.266	.225	.254	.159	.202	.195	-.115	.471	-.225	.326	.909	Provision of ICT accessibility
	OBSpolitics_I	.730	.076	-.004	.107	.054	.244	.012	.221	.181	.004	.011	.910	Understanding the institutional culture and politics that exist and obstacles to look for change
	OBSskills_I	.095	.023	.062	.106	.791	.125	.042	.162	.181	.201	-.070	.909	Business intelligence competency and skills
	OBSstandards_I	.150	.416	.010	-.167	.005	-.132	.575	.113	.351	.119	.009	.910	Creating technology standards
	OBSstratalign_I	.148	.813	-.014	-.050	-.041	.098	.232	.111	.070	.134	-.230	.911	Business Strategy alignment
Technology Strategies	TSadopten_I	.092	.375	.369	.022	.689	.139	.009	-.053	-.078	.021	.170	.910	User adoption enablement
	TSassess_I	.197	.519	.121	.341	-.303	.244	-.009	.110	.351	-.037	-.055	.912	Assessment of current BI/IT and business relationship
	TSBIStandards_I	.042	.065	.173	.050	.207	.147	.229	.811	.162	.005	-.055	.911	Business Intelligence Standards and Frameworks
	TScomms_I	.041	.197	.207	.326	.222	-.091	.053	.192	.579	.216	-.020	.909	Communication Plan to various stakeholders for BI/IT implementations
	TSHETDATAACC_I	.108	.243	.401	.197	-.255	.135	-.185	.410	-.191	.339	-.154	.911	Business Intelligence data quality
	TSmethods_I	.137	.077	.128	.088	.247	.199	-.017	-.029	.192	.782	.181	.911	Methodological processes for BI implementations
	TSplan_I	.161	.180	.036	-.114	.004	.177	.115	.007	.786	.097	.045	.912	Organizational Plan to establish a business case for BI investment
	TSrelations_I	.042	.679	.102	.228	.142	.008	-.008	-.083	.195	-.168	.189	.910	Relationship between BI/IT and core business of the institution
	TSrepstandards_I	.026	.348	.219	.074	.178	.608	.110	.094	-.002	.259	.252	.910	Business intelligence standards
	TStraining_I	.166	-.142	.584	.351	.053	-.314	.092	.307	.145	-.055	-.015	.909	Training plan for the users
		TSvarusers_I	.118	-.010	.102	.113	.172	.795	-.064	.196	.159	.079	-.048	.912
	Cronbach	.980	.970	.970	.970	.970	.910	.911	.912	.910	.914	.911		

APPENDICES

D15- Total Variance of Observed BI Importance Variables

Total Variance Explained: Business Intelligence Importance measures									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.978	26.405	26.405	8.978	26.405	26.405	3.862	11.359	11.359
2	2.949	8.673	35.078	2.949	8.673	35.078	3.543	10.420	21.779
3	2.207	6.491	41.569	2.207	6.491	41.569	3.002	8.831	30.609
4	1.994	5.865	47.434	1.994	5.865	47.434	2.297	6.757	37.366
5	1.796	5.283	52.717	1.796	5.283	52.717	2.073	6.096	43.462
6	1.719	5.057	57.774	1.719	5.057	57.774	2.012	5.919	49.382
7	1.479	4.349	62.124	1.479	4.349	62.124	1.941	5.708	55.090
8	1.350	3.970	66.093	1.350	3.970	66.093	1.867	5.491	60.581
9	1.154	3.395	69.489	1.154	3.395	69.489	1.843	5.420	66.001
10	1.061	3.121	72.610	1.061	3.121	72.610	1.645	4.837	70.838
11	1.007	2.961	75.571	1.007	2.961	75.571	1.609	4.733	75.571
12	.958	2.817	78.388						
13	.924	2.716	81.104						
14	.802	2.358	83.462						
15	.687	2.022	85.484						
16	.652	1.917	87.401						
17	.555	1.633	89.034						
18	.517	1.521	90.555						
19	.441	1.297	91.851						
20	.387	1.137	92.989						
21	.356	1.046	94.035						
22	.306	.900	94.935						
23	.291	.857	95.792						
24	.253	.744	96.536						
25	.198	.583	97.120						
26	.176	.518	97.638						
27	.169	.496	98.134						
28	.151	.444	98.578						
29	.120	.352	98.930						
30	.102	.299	99.229						
31	.084	.246	99.475						
32	.073	.216	99.690						
33	.062	.182	99.872						
34	.043	.128	100.000						

D16- Cohort Analysis for the 2005 First Time Cluster Enrolment

Cohort Year		2005							
Cohort Definition		First-time Cluster Enrolment							
Data Source		HEMIS Data							
Qualification type description		General Academic First Bachelor's Degree							
ENTERING TERM	1st Year 2005	2nd Year 2006	3rd Year 2007	4th Year 2008	5th Year 2009	6th Year 2010	7th Year 2011	8th Year 2012	9th Year 2013
2005 Baseline Enrolment	1,473	1,473	1,473	1,473	1,473	1,473	1,473	1,473	1,473
Enrolments (Retained)	1,437	1,028	723	444	245	124	72	46	28
% Enrolments	98%	70%	49%	30%	17%	8%	5%	3%	2%
Stop-outs (included in Enrolments)	0	38	44	57	55	44	29	12	0
Drop-outs	0	359	162	82	56	41	24	16	18
% Drop-outs	0%	24%	11%	6%	4%	3%	2%	1%	1%
Cumulative Drop-outs	0	359	520	601	657	697	721	737	755
% Cumulative Drop-outs	0%	24%	35%	41%	45%	47%	49%	50%	51%
Graduates	36	50	144	198	143	81	28	10	0
% Graduates	2%	3%	10%	13%	10%	5%	2%	1%	0%
Cumulative Graduates	36	86	230	428	571	652	680	690	690
% Cumulative Graduates	2%	6%	16%	29%	39%	44%	46%	47%	47%

D17: Strategic Enrolment Planning at the University of Venda

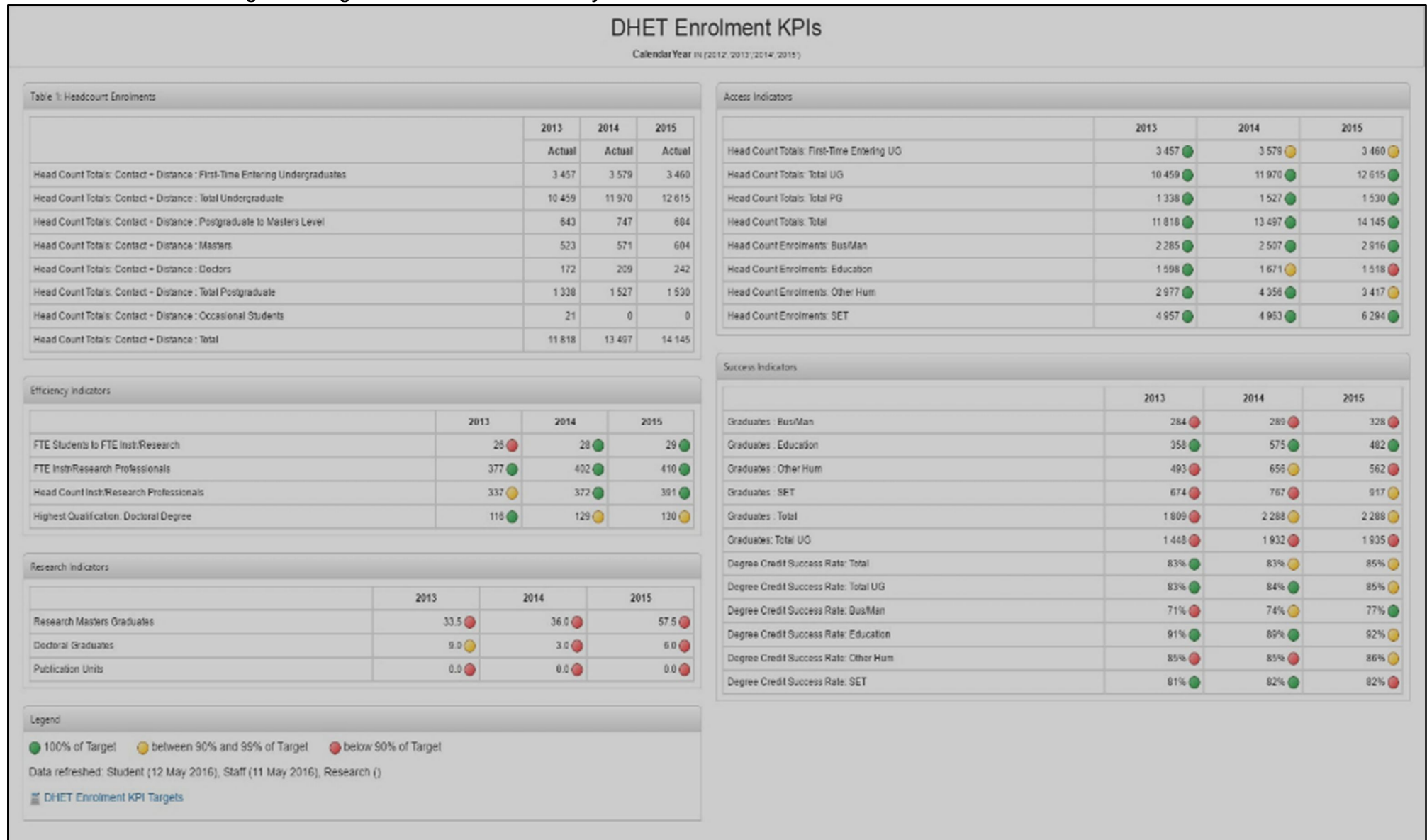
INSTITUTIONAL STRATEGIC ENROLMENT MANAGEMENT : PERFORMANCE PLAN MONITORING									
Report Parameters									
Plan Name	DHET Enrolment Plan								
Responsibility	APPM Administrator (All Responsibilities)								
Milestone	2015, 2016								
Hierarchy Levels	Level 1, Level 2, Level 3								
Snapshots	Current								
Item Name	2015				2016				Item Comments
	Current			Current					
	Actual	Target	Progress	Actual	Target	Progress			
DHET Enrolment Plan			6%			0%			
1 - Access			24%			0%			
1.1 - Headcount - First-Time Entering Undergraduates	3 455.00	3 660.00	0%	0.00	3 660.00	0%			
1.2 - Headcount - Total Undergraduate	12 625.00	11 690.00	0%	0.00	12 136.00	0%			
1.3 - Headcount - Postgraduate to Masters level	689.00	512.00	25%	0.00	518.00	0%			
1.4 - Headcount - Masters	604.00	500.00	0%	0.00	505.00	0%			
1.5 - Headcount - Doctors	243.00	112.00	0%	0.00	113.00	0%			
1.6 - Headcount - Total Postgraduate	1 536.00	1 124.00	0%	0.00	1 136.00	0%			
1.7 - Headcount - Occasional students	0.00	350.00	0%	0.00	351.31	0%			
1.8 - Headcount - Total	14 161.00	13 164.00	0%	0.00	13 623.30	0%			
1.9 - Headcount - SET	6 152.25	5 150.00	100%	0.00	5 280.00	0%			
1.10 - Headcount - BUS/MAN	2 844.17	2 425.00	0%	0.00	2 530.00	0%			
1.11 - Headcount - Education	1 406.08	1 960.00	0%	0.00	2 029.00	0%			
1.12 - Headcount - Other Humanities	3 758.00	3 629.00	82%	0.00	3 784.00	0%			
1.13 - Headcount - Total - Distance	0.00	0.00	100%	0.00	0.00	0%			
2 - Success			0%			0%			
2.1 - Graduates - Total Undergraduate	0.00	2 258.00	0%	0.00	2 343.00	0%			
2.2 - Graduates Total	0.00	2 533.00	0%	0.00	2 686.00	0%			

APPENDICES

2.3 - Success Rate - SET	33.56 %	97.00 %	0%	0.00 %	98.00 %	0%
2.4 - Success Rate - BUS/HUM	36.81 %	76.00 %	0%	0.00 %	72.00 %	0%
2.5 - Success Rate - Education	36.74 %	97.00 %	0%	0.00 %	98.00 %	0%
2.6 - Success Rate - Other Humanities	36.56	93.00	0%	0.00	90.00	0%
2.7 - Success Rate - Total	35.80 %	92.00 %	0%	0.00 %	91.00 %	0%
3 - Efficiency			0%			0%
3.1 - Staff Headcount - Instruction/research professionals	0.00	380.00	0%	0.00	385.00	0%
3.2 - Staff FTE - Instruction/research professionals	0.00	362.14	0%	0.00	367.29	0%
3.3 - Highest Qualification Perm Instr/Res Staff - Doctoral degree	0.00	135.24	0%	0.00	138.50	0%
3.4 - Student FTE per Staff Instr/Res FTE	0.00	28.31	0%	0.00	29.28	0%
4 - Research			0%			0%
4.1 - Research	0.00	210.00	0%	0.00	230.00	0%
4.2 - Research Output - Research Masters Graduates	0.00	80.00	0%	0.00	90.00	0%
4.3 - Research Output - Doctoral Graduates	0.00	25.00	0%	0.00	30.00	0%
4.4 - Research Output - Total	0.00	365.00	0%	0.00	410.00	0%
4.5 - Research Outputs per Perm Acad Staff	0.00	0.96	0%	0.00	1.06	0%

Report Legend				
Icon	Name	Minimum	Maximum	Score
	Not started yet	0	0	0
	Groundwork barely done	1	39	0.5
	Not near completion	40	59	1
	Substantial work still needed	60	89	1.5
	Very little needs to be done	90	99	2
	Completed	100	100	3
	Completed (Exceeds Expectations)	101	110	4
	Completed (Exceptional)	111	120	5
	Progress Override			

D18- Dashboard for Monitoring the Strategic Enrolment Plan at University of Venda



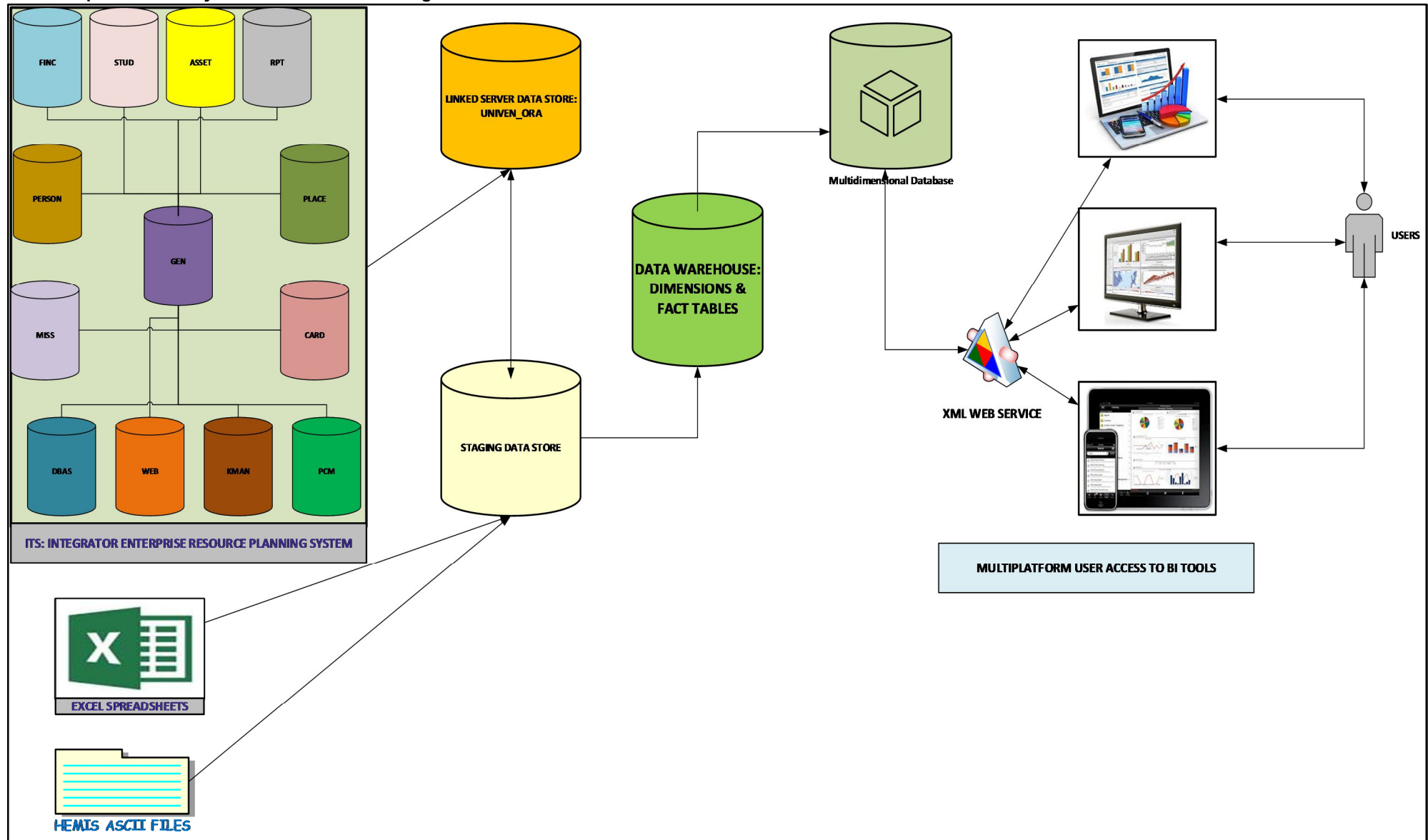
Legend

● 100% of Target
 ● between 90% and 95% of Target
 ● below 90% of Target

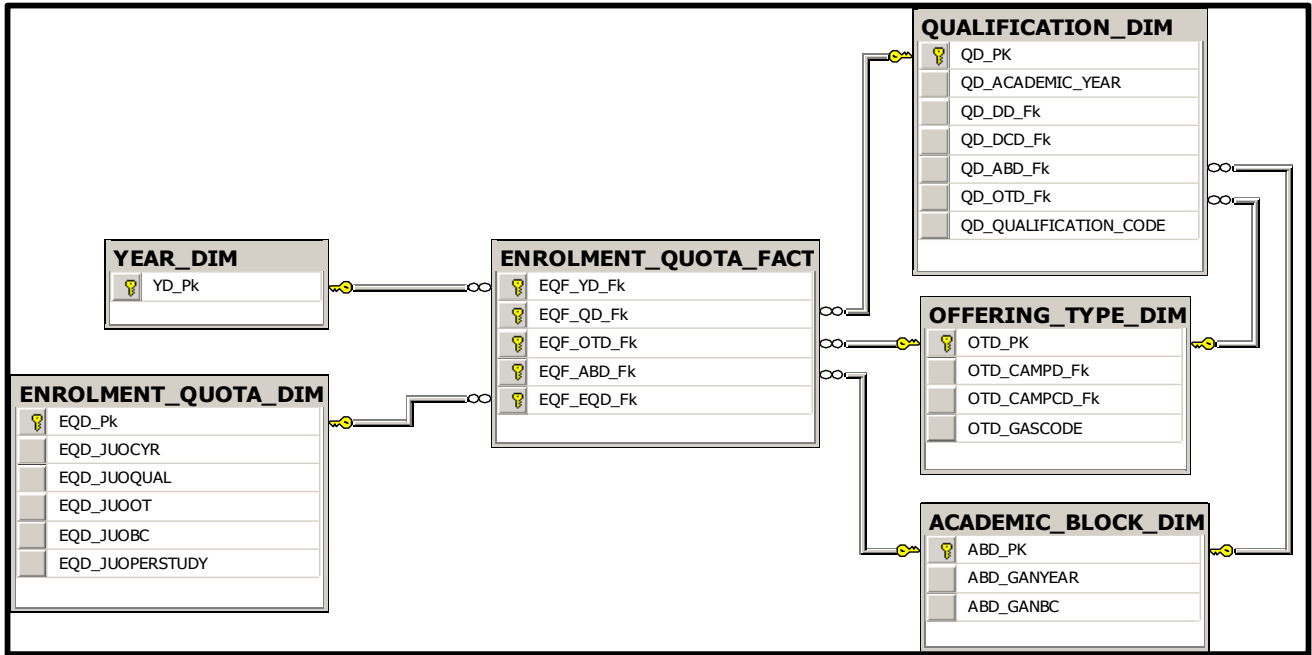
Data refreshed: Student (12 May 2016), Staff (11 May 2016), Research ()

[DHET Enrolment KPI Targets](#)

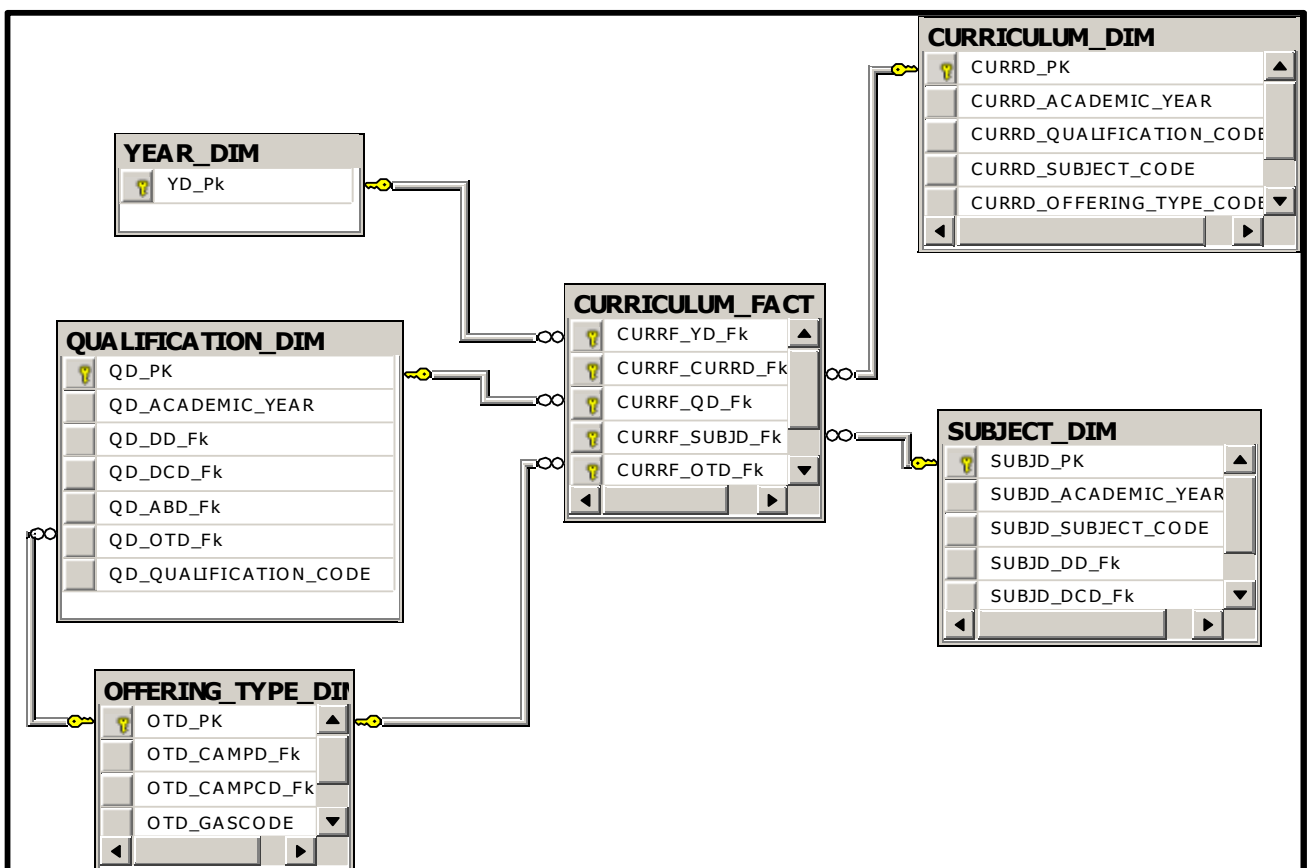
D19- Complete University of Venda Business Intelligence Solution



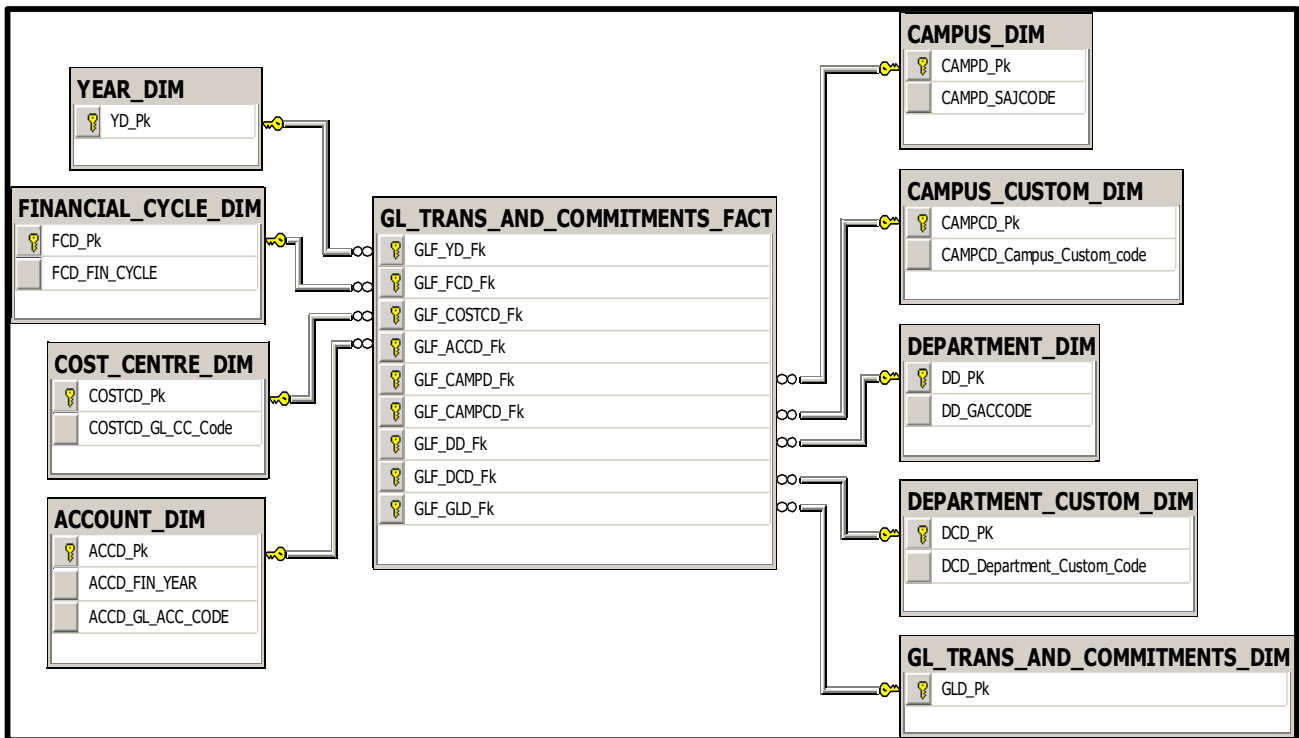
D20 - ITS Views Data Warehouse Architecture at University of Venda



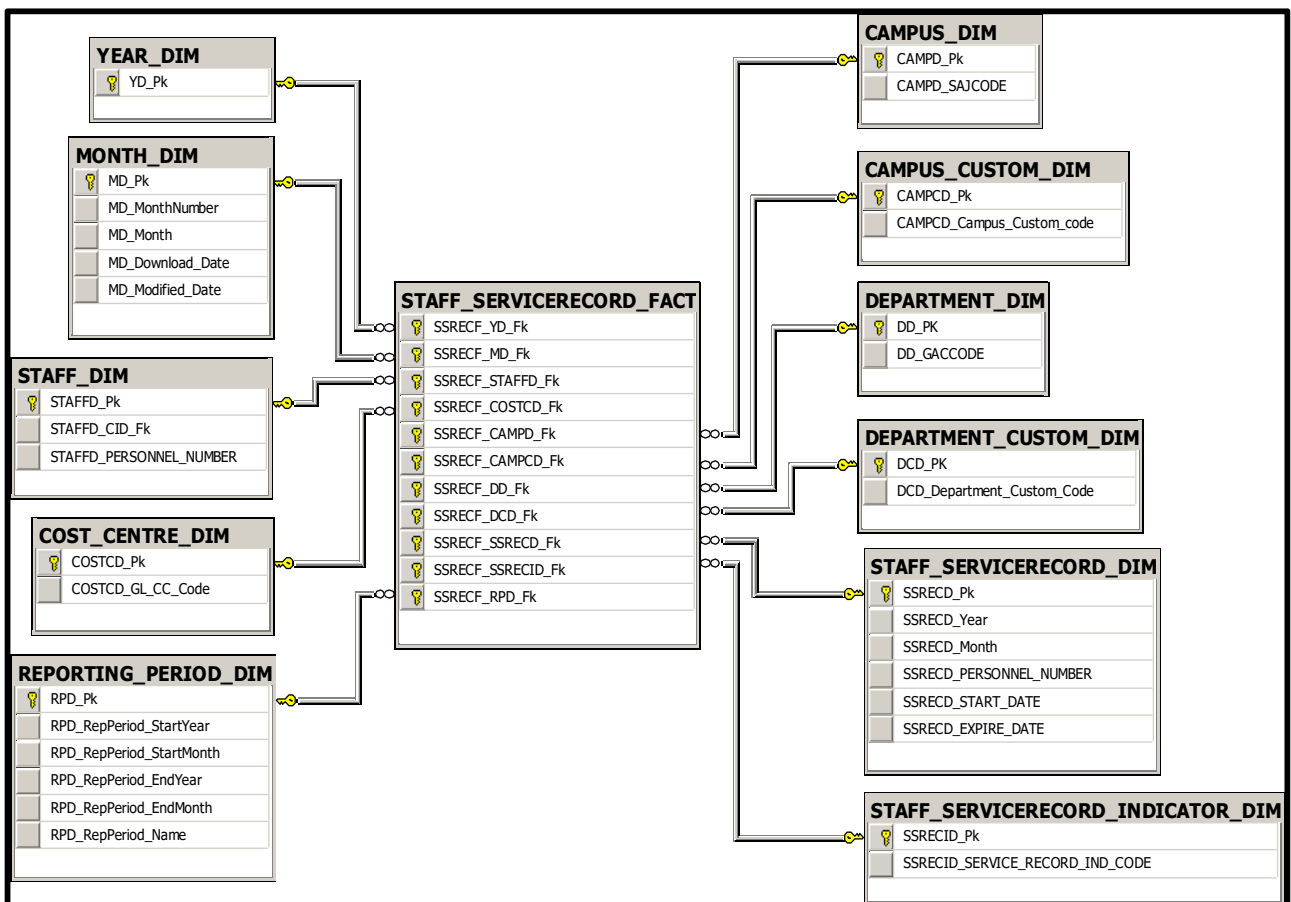
Enrolment Fact Table



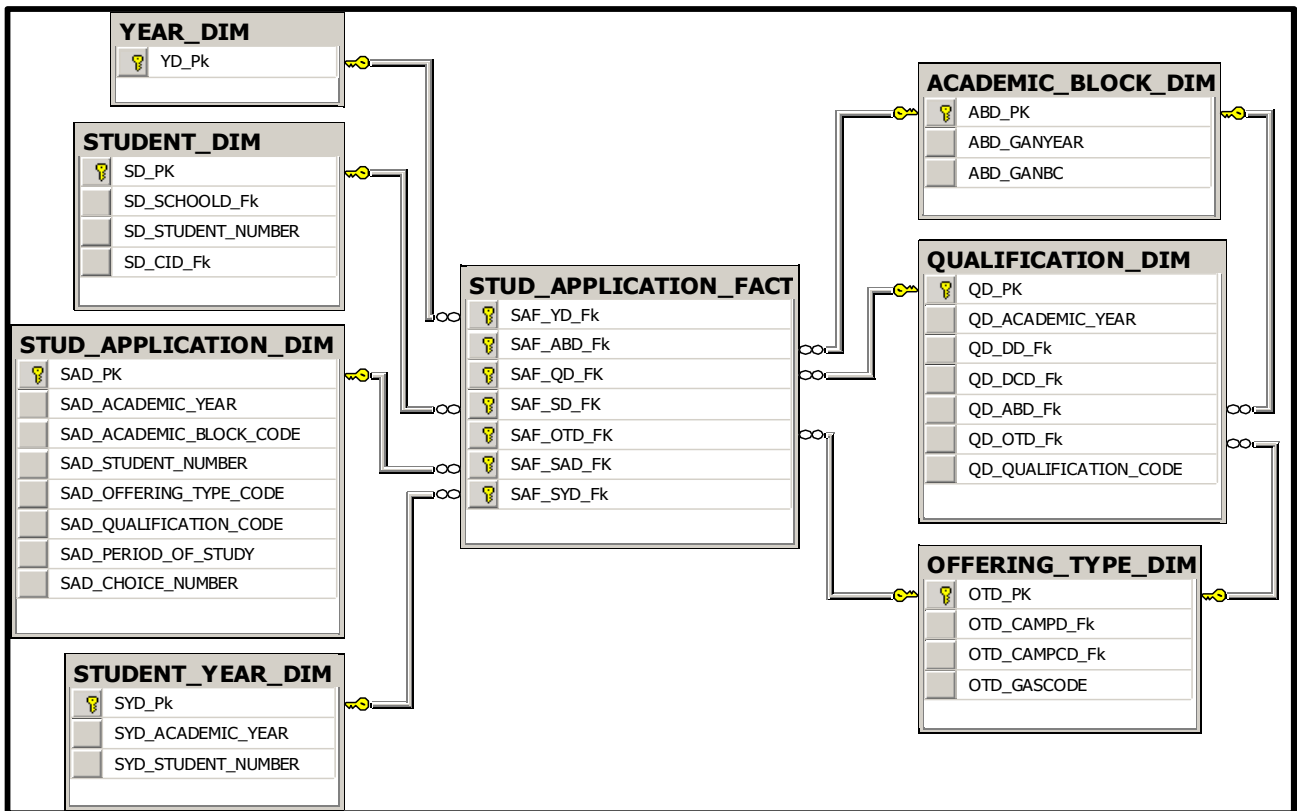
Curriculum Fact Table



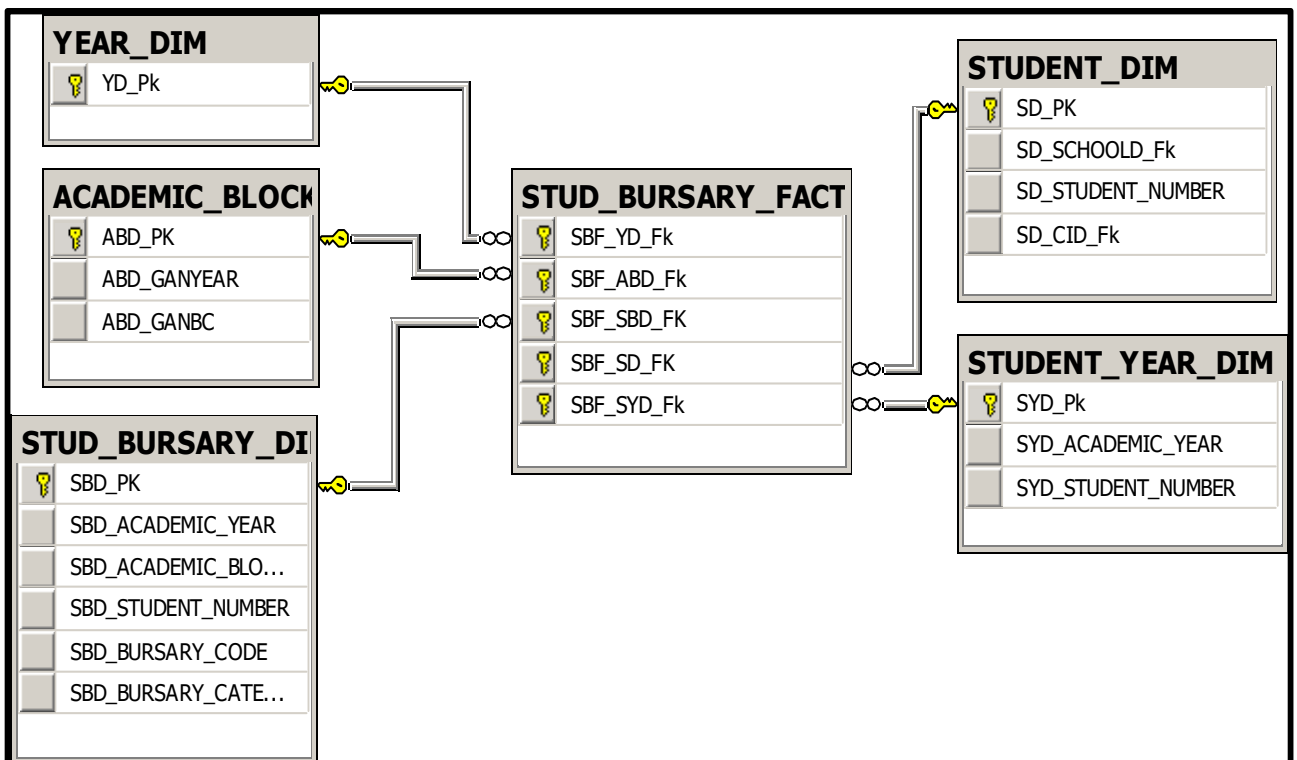
General Ledger Transactions and Commitments



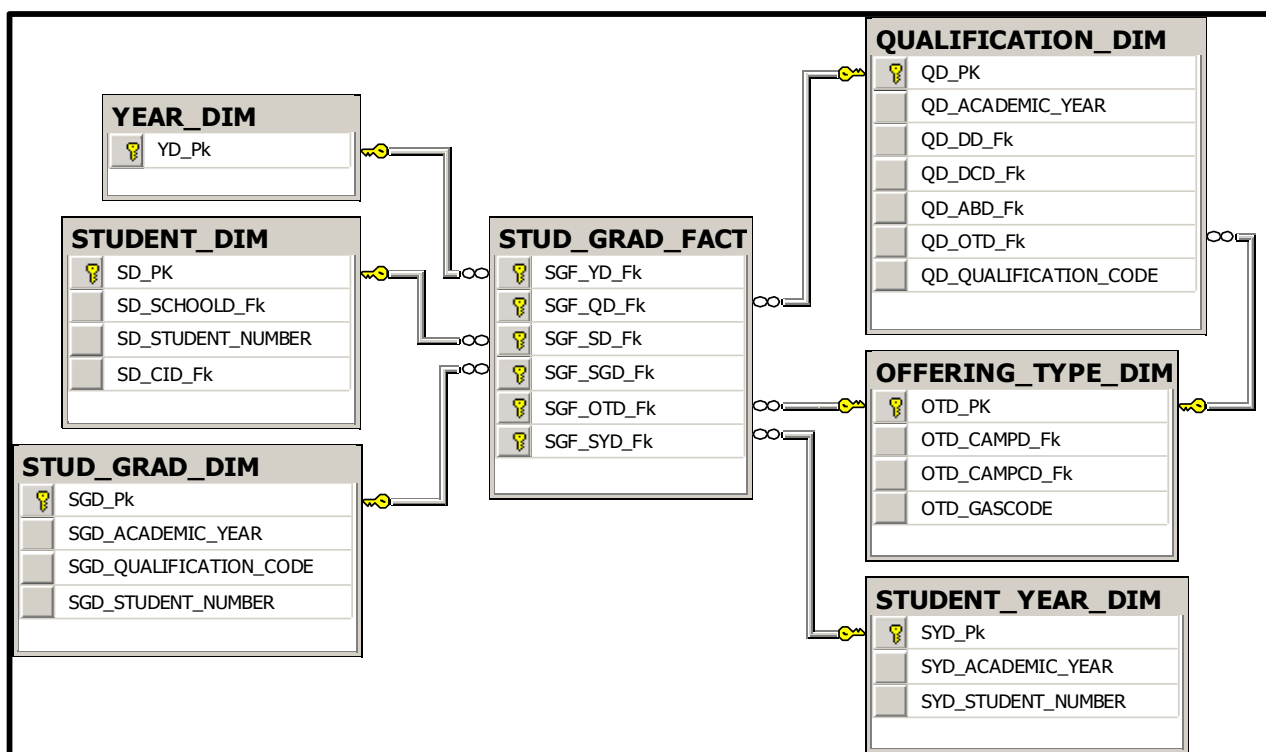
Staff Service Records



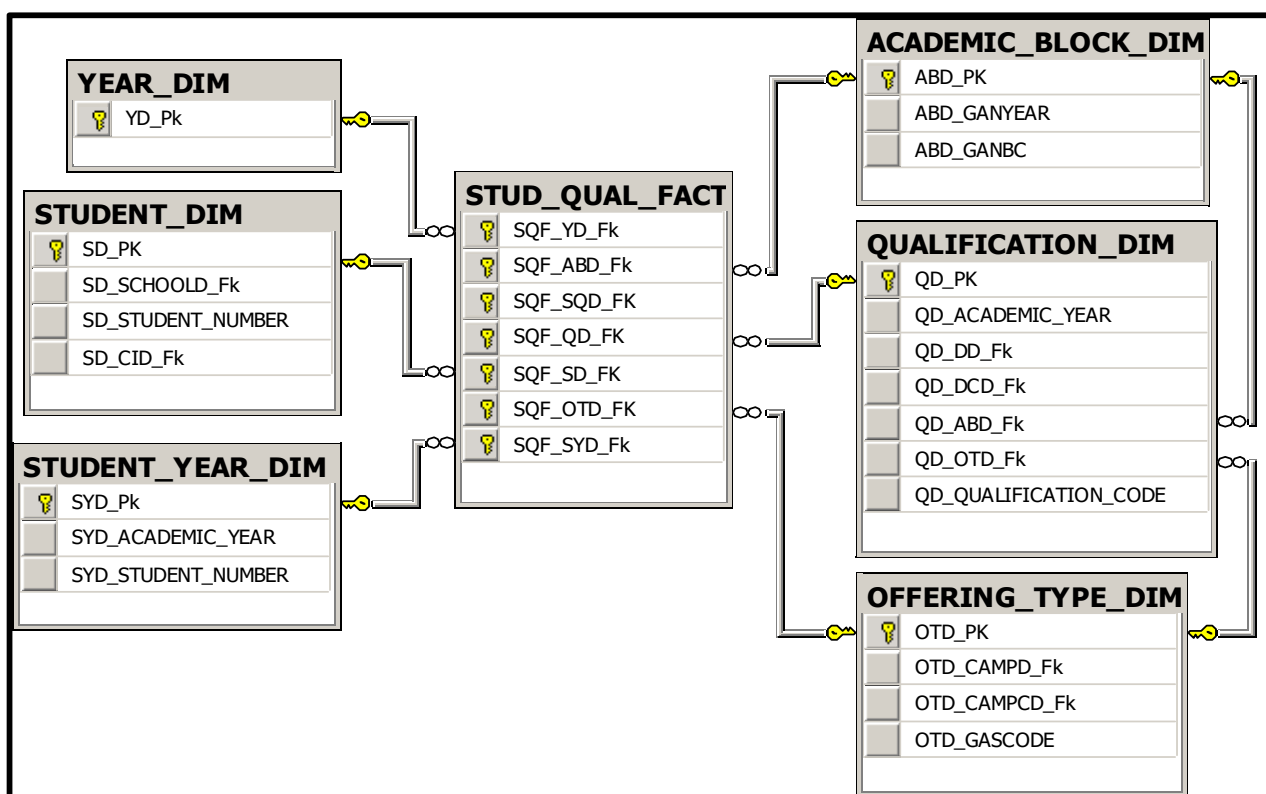
Student Application Fact Table



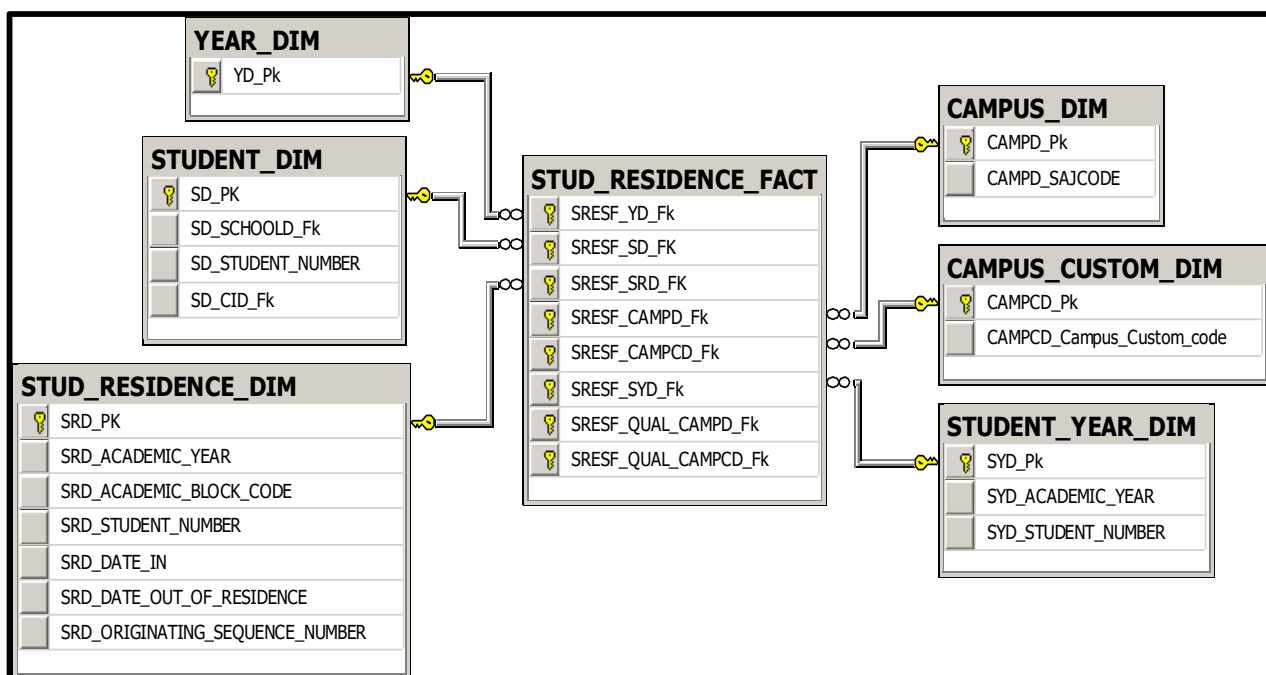
Student Bursary Fact Table



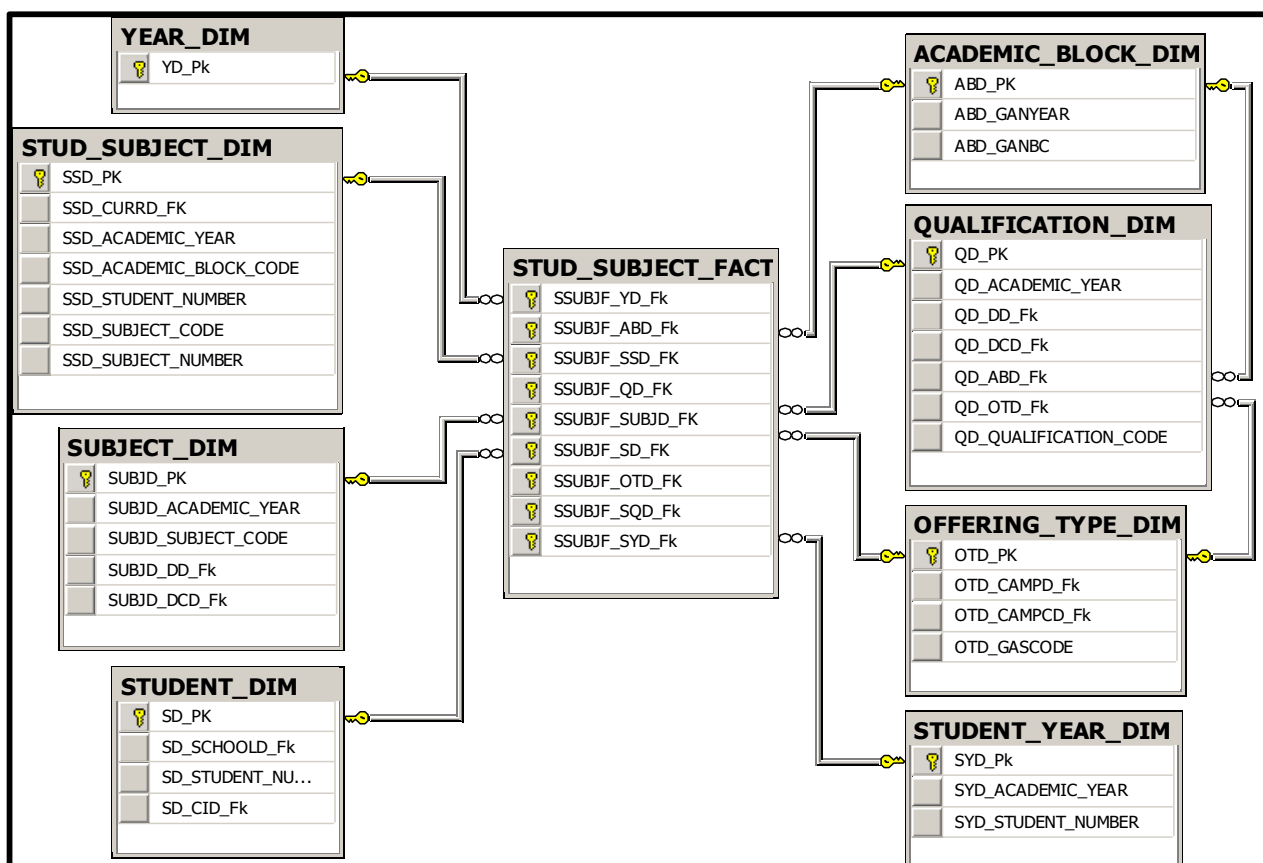
Graduates Fact Table



Student Qualifications Fact



Student Residence Fact



Student Subjects Facts

APPENDICES

E1: Financial Viability Academic Entities at Univen for 2011-2012 Academic Years

Acad Level2	Univen						
Acad Level3	All						
Actual							
				Model Year			
Stucture Level2 Name	Stucture Level3 Name	Stucture Level4 Name	Stucture Level5 Name	2011	2012		
Recurrent Items	Income	State appropriations - Subsidies and Grants		R 161 606 701.00	R 182 891 974.00		
		Teaching Input		R 44 632 872.00	R 54 319 230.00		
		Research Output Graduate Grant		R 3 861 058.00	R 8 532 182.00		
		Other Grants		R 0.00	R 0.00		
		State appropriations - Subsidies and Grants Total		R 210 100 631.00	R 245 743 386.00		
		Tuition and other Fee		R 89 680 970.00	R 147 341 480.00		
		Tuition and other Fee Total		R 89 680 970.00	R 147 341 480.00		
		Income from contracts		R 11 085.73	R 340 637.80		
		For Other Activities		R 0.00	R 0.00		
		For Research		R 0.00	R 0.00		
		Income from contracts Total		R 11 085.73	R 340 637.80		
		Sales of Goods and Services		R 442 350.73	R 542 082.63		
		Sales of Goods and Services Total		R 442 350.73	R 542 082.63		
	Income Total		R 300 235 037.46	R 393 967 586.43			
	Expenditure	Personnel	Academic professional	-R 156 148 096.08	-R 166 279 330.35		
			Other personnel	-R 15 766 318.01	-R 23 571 737.09		
			Leave pay expenditure	-R 7 876 489.83	-R 5 188 674.69		
			Personnel Total	-R 179 790 903.92	-R 195 039 742.13		
		Other current operating expenses		-R 17 345 775.22	-R 23 444 132.76		
		Other current operating expenses Total		-R 17 345 775.22	-R 23 444 132.76		
		Research expenses		-R 14 484 612.05	-R 16 226 174.95		
		Research expenses Total		-R 14 484 612.05	-R 16 226 174.95		
	Expenditure Total		-R 211 621 291.19	-R 234 710 049.84			
	Contribution			R 88 613 746.27	R 159 257 536.59		
		Total		R 88 613 746.27	R 159 257 536.59		
	Contribution Total			R 88 613 746.27	R 159 257 536.59		
Recurrent Items Total				R 177 227 492.54	R 318 515 073.18		
Overheads	Academic Services			-R 29 575 553.22	-R 34 800 948.52		
		Total		-R 29 575 553.22	-R 34 800 948.52		
	Academic Services Total			-R 29 575 553.22	-R 34 800 948.52		
	Administrative Services			-R 95 086 152.58	-R 118 314 889.07		
		Total		-R 95 086 152.58	-R 118 314 889.07		
	Administrative Services Total			-R 95 086 152.58	-R 118 314 889.07		
	Financial Services			R 106 610 228.70	R 118 802 784.00		
		Total		R 106 610 228.70	R 118 802 784.00		
	Financial Services Total			R 106 610 228.70	R 118 802 784.00		
	Management			-R 52 447 757.54	-R 64 966 873.66		
		Total		-R 52 447 757.54	-R 64 966 873.66		
	Management Total			-R 52 447 757.54	-R 64 966 873.66		
	Other			R 15 908 354.97	R 24 721 414.36		
		Total		R 15 908 354.97	R 24 721 414.36		
Other Total			R 15 908 354.97	R 24 721 414.36			
Overheads Total				-R 54 590 879.67	-R 74 558 512.89		
Surplus for the year				R 34 022 866.60	R 84 699 023.70		
		Total		R 34 022 866.60	R 84 699 023.70		
	Total			R 34 022 866.60	R 84 699 023.70		
Surplus for the year Total				R 34 022 866.60	R 84 699 023.70		
DATA DRIVERS	DATABOUND	Academic PE Staff and Student Headcounts		R 10 664.00	R 10 649.00		
		Academic PE Staff and Student Headcounts Total		R 10 664.00	R 10 649.00		
		Academic Staff FTE		R 345.18	R 350.63		
		Academic Staff FTE Total		R 345.18	R 350.63		
		Graduates		R 2 291.00	R 1 764.00		
		Graduates Total		R 2 291.00	R 1 764.00		
		Permanent Academic Staff Headcount		R 322.00	R 326.00		
		Permanent Academic Staff Headcount Total		R 322.00	R 326.00		
		Permanent Staff Headcount		R 381.00	R 383.00		
		Permanent Staff Headcount Total		R 381.00	R 383.00		
		Staff FTE		R 401.49	R 406.04		
		Staff FTE Total		R 401.49	R 406.04		
		Student FTE Enrolments		R 8 418.32	R 8 121.80		
		Student FTE Enrolments Total		R 8 418.32	R 8 121.80		
		Student FTE Passes		R 6 941.74	R 6 791.02		
		Student FTE Passes Total		R 6 941.74	R 6 791.02		
		Student Headcount Enrolments		R 10 342.00	R 10 323.00		
		Student Headcount Enrolments Total		R 10 342.00	R 10 323.00		
		Teaching Input Units		R 18 212.69	R 20 066.78		
		Teaching Input Units Total		R 18 212.69	R 20 066.78		
		Teaching Output Units		R 2 480.87	R 2 016.12		
		Teaching Output Units Total		R 2 480.87	R 2 016.12		
		DATABOUND Total			R 60 800.29	R 61 197.40	
		DATA DRIVERS Total				R 60 800.29	R 61 197.40

E2: IDSC Letter for PowerHEDA applications



Alfred Mutanga
University of Venda

15 June 2015

PhD Research at the University of Venda

To whom it may concern,

This letter confirms that IDSC sponsored the following two Higher Education Data Analyser (HEDA) Modules at the University of Venda with the purpose of utilizing the modules for Alfred Mutanga's PhD research:

- Performance Evaluation Scorecard – now being replaced by the Annual Performance Plan Monitor (APPM)
- Funding Allocation Model (FAM)

The value of the modules amount to R140 000.00 per year for 2015 and 2016.

I trust you find this in order and wish you all the very best in finalising your research.

Kind regards,



Prof Amanda Lourens
Director: IDSC Consulting

E3: University of Venda Government Funding Allocation for 2014/2015



Block Grant Calculations for 2014/2015

Report Parameters:	
Institution	H17: University of Venda
Scenario	2012 Final Block Grant Calculation

TABLE 1: ACTUAL UNWEIGHTED TEACHING INPUT FULL-TIME EQUIVALENTS (FTES)						
COURSE LEVELS	FUNDING WEIGHTS	UNDERGRAD & EQUIVALENT	HONOURS & EQUIVALENT	MASTERS & EQUIVALENT	DOCTORS & EQUIVALENT	TOTAL
FUNDING GROUP		1.0	2.0	3.0	4.0	
CONTACT		6,174.372	1,689.153	208.629	49.646	8,121.800
FUNDING GROUP 1	1.0	1,756.442	590.698	53.004	17.413	2,417.557
FUNDING GROUP 2	1.5	2,314.538	622.212	42.025	14.689	2,993.464
FUNDING GROUP 3	2.5	615.467	91.824	11.722	3.779	722.792
FUNDING GROUP 4	3.5	1,487.925	384.419	101.878	13.765	1,987.987
DISTANCE		0.000	0.000	0.000	0.000	0.000
FUNDING GROUP 1	0.5	0.000	0.000			0.000
FUNDING GROUP 2	0.75	0.000	0.000			0.000
FUNDING GROUP 3	1.25	0.000	0.000			0.000
FUNDING GROUP 4	1.75	0.000	0.000			0.000
FUNDING GROUP 1	1.0			0.000	0.000	0.000
FUNDING GROUP 2	1.5			0.000	0.000	0.000
FUNDING GROUP 3	2.5			0.000	0.000	0.000
FUNDING GROUP 4	3.5			0.000	0.000	0.000
TOTAL		6,174.372	1,689.153	208.629	49.646	8,121.800

TABLE 2: TEACHING INPUT GRANT				
FUNDING CRITERIA			UNIVERSITY	UNIVERSITY SECTOR
ACTUAL WEIGHTED TEACHING INPUT UNITS FOR YEAR:	2012			
CONTACT TUITION			20,066.886	-
DISTANCE TUITION			0.000	-
TOTAL		(T)	20,066.886	1,211,265.000
PLANNED WEIGHTED & GOV FUNDED TEACHING INPUT UNITS	2012	(U)	20,526.679	1,169,143.443
% OVERENROLMENT IN TEACHING INPUT UNITS (TAJ-1)			-2.2%	3.6%
GRANT FOR YEAR 2014/2015			R223,207,106	R12,713,266,000

TABLE 3: INSTITUTIONAL FACTOR GRANTS				
GRANT CATEGORY	FUNDING CRITERIA	WEIGHTING FACTOR ON GLIDING SCALE	UNIVERSITY	UNIVERSITY SECTOR
1. DISADVANTAGED STUDENTS OF YEAR 2012	COLOURED AND BLACK ENROLLED FTE RSA STUDENTS (A)		7,585.455	0.000
	TOTAL ENROLLED FTE STUDENTS (B)		8,121.800	0.000
	% DISADVANTAGE FTE ENROLLED STUDENTS (A/B)	1.100 (C)	93.40%	0.00%
	GOVFUNDED CONTACT & DISTANCE TEACHING INPUT UNITS (D)		20,526.679	1,169,143.443
	ADDITIONAL WEIGHTED TEACHING INPUT UNITS (E) = (C X D) - D		2,052.669	0.000
GRANT FOR YEAR 2014/2015 (L)			0	R0
2. INSTITUTIONAL SIZE OF YEAR 2012	TOTAL CONTACT & DISTANCE FTE ENROLLED STUDENTS (F)	1.121 (G)	8,121.800	0.000
	GOVFUNDED CONTACT & DISTANCE TEACHING INPUT UNITS (D)		20,526.679	1,169,143.443
	ADDITIONAL WEIGHTED TEACHING INPUT UNITS (H) = (G X D) - D		2,474.649	0.000
GRANT FOR YEAR 2014/2015 (M)			0	R0
TOTAL ADDITIONAL WEIGHTED UNITS (E + H)			4,527.318	99,462.413
TOTAL GRANT (L + M)			R50,224,059	R1,103,392,000



Block Grant Calculations for 2014/2015

TABLE 4: TEACHING OUTPUT GRANT				
ACTUAL TEACHING OUTPUT OF YEAR 2012	FUNDING CRITERIA FOR ACTUAL OUTPUT	FUNDING WEIGHTS FOR WEIGHTED TOTAL	UNIVERSITY	UNIVERSITY SECTOR
	1 ST CERTIFICATES AND DIPLOMAS OF 2 YEARS OR LESS	0.5	1	-
	1 ST DIPLOMAS AND BACHELOR'S DEGREES: 3 YEARS	1.0	561	-
	PROFESSIONAL 1 ST BACHELOR'S DEGREE: 4 YEARS AND MORE	1.5	819	-
	POSTGRADUATE AND POST-DIPLOMA DIPLOMAS	0.5	139	-
	POSTGRADUATE BACHELORS' DEGREES	1.0	2	-
	HONOURS DEGREES/HIGHER DIPLOMAS/POST-GRAD DIPL	0.5	122	-
	NON-RESEARCH MASTERS DEGREES AND DIPLOMAS	0.5	5	-
	TOTAL UNWEIGHTED TEACHING OUTPUTS		1,740	-
	TOTAL WEIGHTED TEACHING OUTPUT UNITS		2,016.125	149,138.479
GRANT FOR YEAR 2014/2015			R40,210,370	R2,974,475
TABLE 5: RESEARCH OUTPUT GRANT				
ACTUAL RESEARCH OUTPUT OF YEAR 2012	FUNDING CRITERIA FOR ACTUAL OUTPUT	FUNDING WEIGHTS FOR WEIGHTED TOTAL	UNIVERSITY	UNIVERSITY SECTOR
	ARTICLES PUBLISHED IN ACCREDITED JOURNALS	1.0	-	-
	PUBLISHED CONFERENCE PROCEEDINGS	1.0	-	-
	BOOKS PUBLISHED FOR THE SPECIALIST	1.0	-	-
	TOTAL UNWEIGHTED RESEARCH PUBLICATION UNITS	1.0	127.850	0.000
	NO OF RESEARCH MASTER GRADUATE HEADS	1.0	19.750	0.000
	NO OF DOCTORAL GRADUATE HEADS	3.0	4.000	0.000
	TOTAL UNWEIGHTED RESEARCH OUTPUTS		151.600	0.000
			159.600	24,076.852
GRANT FOR YEAR 2014/2015			R18,362,373	R2,770,101,000
TABLE 6: SUMMARY OF SUB-BLOCK GRANTS				
	UNIVERSITY	UNIVERSITY SECTOR		
TEACHING INPUT GRANT	R223,207,106	R12,713,266,000		
INSTITUTIONAL FACTOR GRANT	R50,224,059	R1,103,392,000		
TEACHING OUTPUT: ACTUAL	R40,210,370	R2,974,475,000		
RESEARCH OUTPUT: ACTUAL	R18,362,373	R2,770,101,000		
TEACHING OUTPUT DEVELOPMENT	R8,905,000	R609,500,000		
RESEARCH OUTPUT DEVELOPMENT	R8,040,704	R187,429,000		
MULTI-CAMPUS GRANT	R0	-		
FOUNDATION GRANT	R4,279,000	-		
CLINICAL TRAINING	R3,341,000	-		
VETERINARY SCIENCE		-		
TOTAL (R'000)	R356,569,612	R20,358,163,000		
Actual proportion of approved Headcount Enrolments (2% variation allowed)			106.56%	

APPENDICES

E4: Correlations of the TAM Survey variables at University of Venda

		AGE	PERCEIVED_EASE_OF_USE	PERCEIVED_USEFULNESS	ATTITUDE_TOWARDS_USE	INTENTION_TO_USE	FACILITATING_FACTORS	ACTUAL_USE
AGE	Pearson Correlation	1	-0.05	-0.14	-0.01	0.03	0.08	0.06
	Sig. (2-tailed)		0.384	0.025	0.916	0.579	0.233	0.344
PERCEIVED_EASE_OF_USE	Pearson Correlation	-0.05	1	0.18	0.06	0.18	0.13	0.33
	Sig. (2-tailed)	0.38		0.003	0.381	0.005	0.045	0
PERCEIVED_USEFULNESS	Pearson Correlation	-0.14	0.18	1	0.32	0.38	0.34	0.07
	Sig. (2-tailed)	0.03	0.003		0	0	0	0.268
ATTITUDE_TOWARDS_USE	Pearson Correlation	-0.01	0.06	0.32	1	0.2	0.32	0.1
	Sig. (2-tailed)	0.92	0.381	0		0.001	0	0.116
INTENTION_TO_USE	Pearson Correlation	0.03	0.18	0.38	0.2	1	0.2	0.50
	Sig. (2-tailed)	0.58	0.005	0	0.001		0.001	0.424
FACILITATING_FACTORS	Pearson Correlation	0.08	0.13	0.34	0.32	0.2	1	0.16
	Sig. (2-tailed)	0.23	0.045	0	0	0.001		0.012
ACTUAL_USE	Pearson Correlation	0.06	0.33	0.07	0.1	0.50	0.16	1
	Sig. (2-tailed)	0.34	0	0.268	0.116	0.424	0.012	

F1 - Ethical Clearance Certificates from South African Higher Education Institutions

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Mr A Mutanga

Student No:
11640358

PROJECT TITLE: **A Context-Aware Business
Intelligence Framework for South African Higher
Education.**

PROJECT NO: SMS/14/BMA/01/1411

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Prof A Kadyamatimba	University of Venda	Promoter
Dr JJ Zaaiman	University of Venda	Co-Promoter
Prof N Mavetera	North West University	Co-Promoter
Mr A Mutanga	University of Venda	Investigator - Student

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE

Date Considered: November 2014

Decision by Ethical Clearance Committee Granted

Signature of Chairperson of the Committee:

Name of the Chairperson of the Committee: Prof. G.E. Ekosse




University of Venda

PRIVATE BAG X5050, THOHOYANDOU, 0950, LIMPOPO PROVINCE, SOUTH AFRICA
TELEPHONE (015) 962 8816/8313 FAX (015) 962 9060
"A quality driven financially sustainable, rural-based Comprehensive University"



RESEARCH PERMISSION SUB-COMMITTEE OF SRIHDC

19 August 2015

Ref #: 2015_RPSC_070

Mr. Alfred Mutanga

Student #:

Staff #: 11640358

Dear Mr. Alfred Mutanga,

Decision: Research Permission
Approval for the period **August**
2015 to 31 December 2015

Principal Investigator:

Mr. Alfred Mutanga

University of Venda

mutangaa@tut.ac.za

(012) 382-4343/083 712 4553

Supervisor: Prof. Armstrong Kadyamatimba

Armstrong.kadyamatimba@univen.ac.za

(015) 962-8707/ 082 803 9015

**A study titled: "A Context-Aware Business Intelligence Framework for South African
Higher Education."**

Your application regarding permission to conduct research involving UNISA staff in respect of the above study has been received and was considered by the Research Permission Subcommittee (RPSC) of the UNISA Senate Research and Innovation and Higher Degrees Committee (SRIHDC) on 14 August 2015.

It is my pleasure to inform you that permission has been granted for the study to:

1. Distribute a link to a web-based survey by means of a Lime Survey to Unisa ICT staff, Information Management Specialists, Institutional Researchers and Data Scientists.
2. In line with the Protection of Personal Information Act (POPI Act), No. 4 of 2013 which prohibits the dissemination of personal information without prior consent of the owner, the RPSC does not disseminate Unisa employees and students email addresses to external applicants.



University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

3. The process will be as follows: Human Resource Management is the data curator and is in possession of the required data.
4. Corporate Communications and Marketing will distribute the invite on your behalf.
5. Contact RPSC@unisa.ac.za with all relevant information and the link to the survey for further assistance.

You are requested to submit a report of the study to the Research Permission Subcommittee (RPSC@unisa.ac.za) within 12 months of completion of the study.

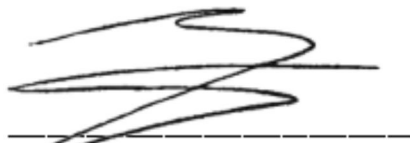
The personal information made available to the researcher(s)/gatekeeper(s) will only be used for the advancement of this research project as indicated and for the purpose as described in this permission letter. The researcher(s)/gatekeeper(s) must take all appropriate precautionary measures to protect the personal information given to him/her/them in good faith and it must not be passed on to third parties.

Note:

*The reference number **2015_RPSC_070** should be clearly indicated on all forms of communication with the intended research participants and the Research Permission Subcommittee.*

We would like to wish you well in your research undertaking.

Kind regards,



PROF L LABUSCHAGNE

EXECUTIVE DIRECTOR: RESEARCH

Tel: +27 12 429 0308 / 2440

Email: llabusch@unisa.ac.za



University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za



UNISA RESEARCH ETHICS REVIEW COMMITTEE

06 July 2015

Dear Mr. Alfred Muthanga,

Decision: Ethics Approval

Ref #: 2015_URERC_008_ER

Mr. Alfred Muthanga

Student #: 11640358

Staff #:

Name: Mr. Alfred Muthanga, Department of Business Management, TUT
(012) 382-4343/ 083 712 4553
mutangaa@tut.ac.za

Supervisor: Prof Armstrong Kadyamatimba, Department of Business Information Systems
University of Venda, Armstrong.kadyamatimba@univen.ac.za
(015) 962-8707/ 082 803 9015

**Proposal: A Context-Aware Business Intelligence Framework for South African
Higher Education.**

Qualification: Doctor of Philosophy

Thank you for the application for research ethics clearance by the Unisa Research Ethics Review Committee for the above mentioned research. Final approval is granted for the study for the period 1 July 2015 till 30 April 2016.

*The **low risk application** was reviewed through an expedited ethics review procedure in compliance with the Unisa Policy on Research Ethics by the University of South Africa Research Ethics Review Committee (URERC).*

The proposed research may now commence with the proviso that:

- 1) The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*
- 2) Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the UNISA Research Ethics Review Committee. An amended application could be requested if there are substantial changes from the*



University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

existing proposal, especially if those changes affect any of the study-related risks for the research participants.

- 3) The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.*

Note:

The reference number 2015_URERC_008_ER should be clearly indicated on all forms of communication with the intended research participants, as well as with the URERC.

Kind regards,



Dr Retha Visagie (pp. Prof Les Labuschagne – Chair Person: URERC)

E-mail: visagr@unisa.ac.za

Tel: (012) 429-2478



University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za



• PO Box 77000 • Nelson Mandela Metropolitan University
• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

Chairperson: Research Ethics Committee (Human)
Tel: +27 (0)41 504-2235

Ref: [H15-BES-BMA-017 Approval]

Contact person: Mrs U Spies

3 September 2015

Dr R Lillah
Faculty: BES
Department: Business Management
01-11-19
South Campus

Dear Dr Lillah

A CONTEXT-AWARE BUSINESS INTELLIGENCE FRAMEWORK FOR SOUTH AFRICAN HIGHER EDUCATION

PRP: Dr R Lillah
PI: Mr A Mutanga

Your above-entitled application served at Research Ethics Committee (Human) for approval.

The ethics clearance reference number is **H15-BES-BMA-017** and is valid for three years. Please inform the REC-H, via your faculty representative, if any changes (particularly in the methodology) occur during this time. An annual affirmation to the effect that the protocols in use are still those for which approval was granted, will be required from you. You will be reminded timeously of this responsibility, and will receive the necessary documentation well in advance of any deadline.

We wish you well with the project. Please inform your co-investigators of the outcome, and convey our best wishes.

Yours sincerely



Prof C Cilliers
Chairperson: Research Ethics Committee (Human)

cc: Department of Research Capacity Development
Faculty Officer: BES



Faculty of Commerce

Private Bag X3, Rondebosch, 7701
2.26 Leslie Commerce Building, Upper Campus
Tel: +27 (0) 21 650 4375/ 5748 Fax: +27 (0) 21 650 4369
E-mail: com-faculty@uct.ac.za
Internet: www.uct.ac.za

June 17, 2015

ALFRED MUTANGA

Department of Business Management, University of Venda

Re: Application for Ethics Approval

Project title: A Context-Aware Business Intelligence Framework for South African Higher Education

Reference Number:

Dear Alfred Mutanga

This letter serves to confirm that the ethics committee has approved the research as described in your submitted protocol.

Please note that you are required to inform the Committee immediately should any changes in the research procedure occur that might affect the experience of the participants. This includes major changes to the questionnaire.

We wish you well for your study.

A/Prof. Ulrike Rivett
Commerce Faculty Ethics in Research Committee

"Our Mission is to be an outstanding teaching and research university, educating for life and addressing the challenges facing our society."

HR194	ACCESS TO UCT STAFF FOR RESEARCH PURPOSES	 UNIVERSITY OF CAPE TOWN (YUNIVESITHI YASEKAKAZI) RECEIVED 09 JUL 2015 ED: HR OFFICE

NOTES

- Forms must be downloaded from the UCT website: <http://www.uct.ac.za/depts/sapweb/forms/forms.htm>
- This form must be completed by applicants who are requesting to access UCT staff for the purpose of research.
- A copy of the research proposal as well as the Ethics Committee approval must be attached.
- It is the responsibility of the researcher/s to apply for ethical clearance from the relevant Faculty's Research in Ethics Committee (RIEC).
- If you are requesting staff information, you are required to complete the HR Information Request Form (HR190) and submit it together with all the required documentation.
- The turnaround time for a reply is **approximately 10 working days unless specified as urgent**.
- Return the completed application form and all the above documentation to Joy Henry via email: joy.henry@uct.ac.za; or deliver to: For the Attention: Executive Director, Human Resources Department, Bremner Building, Room 214, Lower Campus, UCT.

SECTION A: APPLICANT DETAILS

Title	Mr	Name	Alfred Mutanga
Telephone number	0837124553	Email address	mutangaa@tut.ac.za
Student number	11640358	Staff number	
Visiting researcher ID / passport number	DN544012		
Faculty Officer contact details	Prof. Ulrike Rivett Private Bag X3, Rondebosch, 7701 2.26 Leslie Commerce Building, Upper Campus		
University or institution at which employed or a registered student	University of Venda		
Faculty or department in which you are registered or work	School of Management Sciences, Department of Business Management		
Address (if not UCT)	School of Management Sciences, Department of Business Management University of Venda, Private Bag X5050 Thohoyandou, 050		

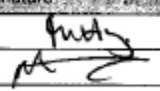
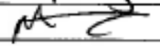
SECTION B: SUPERVISOR DETAILS

	Title and name	Telephone number	Email address
Supervisor	Prof. Armstrong Kadyamatimba	015 962 8707	armstrong.kadyamatimba@univen.ac.za
Co-Supervisor	Prof Nehemiah Mavetera	018 389 2143	nehemiah.mavetera@nwu.ac.za

SECTION C: APPLICANT'S FIELD OF STUDY (if applicable) / TITLE OF RESEARCH PROJECT / STUDY

Degree	Doctor of Philosophy		
Research project or title	A Context-Aware Business Intelligence Framework for South African Higher Education		
Research proposal attached	☒ Yes	☐ No	
Target population (number of UCT staff)	Between 10 to 15 staff members from ICT services, and Management Information Units		
Amount of time required for an interview and/or questionnaire	25 to 30 Minutes		
Lead Researcher details	Alfred Mutanga, 0123824343/0837124553		
Proof of ethical clearance status attached	☒ Yes	☐ No	

SECTION D: FOR OFFICE USE (Approval status to be completed by the Executive Director, Human Resources or Nominee)

Support or approval	Role	Signature	Date
Supported? ☒ Yes ☐ No	Joy Henry (Office Co-Ordinator)		8/7/2015
Approved? ☒ Yes ☐ No	Wiliam Hoosain (Executive Director: HR)		10/07/15



Office of the Deputy Vice Chancellor:
Research, Technology Innovation & Partnerships
Bellville Campus
P O Box 1906
Bellville 7535
Tel: 021-9596242
Email: NhlapoC@cpu.ac.za

22 July 2015

Mr A Mutanga
Management Sciences
Business Management

Dear Mr A Mutanga,

RE: ETHICAL CLEARANCE – CPUT

I am pleased to inform that provisional approval for ethical clearance has been granted to your doctoral study.

A formal approval will follow soonest once the faculty ethics has taken place.

I wish you all the best in your doctoral study.

Sincerely



Dr C Nhlapo
Chair: Senate Ethics Committee



Cape Peninsula University of Technology PO Box 1906 Bellville 7535 www.cpu.ac.za



UNIVERSITEIT • STELLENBOSCH • UNIVERSITY
jou kennisvermoot • your knowledge partner

19 June 2015

Mr Alfred Mutanga
Deputy Director: Strategic Management Support
Tshwane University of Technology

Mr Alfred Mutanga

Concerning research project: *A context-aware business intelligence framework for South African higher education*

The researcher has institutional permission to proceed with this project as stipulated in the institutional permission application. This permission is granted on the following conditions:

- No Stellenbosch University student or staff numbers or e-mail addresses will be provided to the researcher. Facilitation of the survey invitations will be handled by a member of Stellenbosch University staff (Professor Xikombiso Mbhenyane).
- The researcher must obtain ethical clearance before commencing with this study.
- Participation is voluntary.
- Persons may not be coerced into participation.
- Persons who choose to participate must be informed of the purpose of the research, all the aspects of their participation, the risks to participation, their role in the research and their rights as participants. Participants must consent to participation. The researcher may not proceed until she is confident that all the before mentioned has been established and recorded.
- Persons who choose not to participate may not be penalized as a result of non-participation.
- Participants may withdraw their participation at any time, and without consequence.
- The data must be responsibly and suitably protected.
- The researcher must pay due diligence in seeing that the data is handled in the strictest confidence.
- Data must be collected and processed in a way that ensures the anonymity of all participants.
- The use of the collected data may not be extended beyond the purpose of this study.
- Individuals may not be identified in the report(s) or publication(s) of the results of the study.
- The privacy of individuals must be respected and protected.
- The researcher must conduct her research within the provisions of the Protection of Personal Information Act, 2013.

Best wishes,



Prof Ian Cloete
Senior Director: Institutional Research and Planning



Afdeling Institusionele Navorsing en Beglansing • Institutional Research and Planning Division
Private Sak/Private Bag X1 • Stellenbosch • 7602 • Suid-Afrika/South Africa
Tel. +27 21 808 6887 • Faks/Fax +27 21 808 4586



*Directorate for Research and Postgraduate Support
Durban University of Technology
Tromso Annexe, Steve Biko Campus
P.O. Box 1334, Durban 4000
Tel.: 031-3732576/7
Fax: 031-3732946
E-mail: moyos@dut.ac.za*

25 August 2015

Mr Alfred Mutanga
c/o Department of Business Management, School of Management Sciences
University of Venda

Dear Mr Mutanga

PERMISSION TO CONDUCT RESEARCH AT THE DUT

Your email correspondence in respect of the above refers. I am pleased to inform you that the Institutional Research Committee (IRC) has granted permission for you to conduct your research "A Context-Aware Business Intelligence Framework for South African Higher Education" at the Durban University of Technology.

We would be grateful if a summary of your key research findings can be submitted to the IRC on completion of your studies.

Kindest regards.
Yours sincerely



PROF. S. MOYD
DIRECTOR: RESEARCH AND POSTGRADUATE SUPPORT



University of Zululand, Private Bag X1001, KwaDlangezwa, 3886
W: www.unizulu.ac.za

T: +27 35 902 6887 F: +27 86 616 7707 E: ManqeleS@unizulu.ac.za

Deputy Vice-Chancellor: Research and Innovation Office

Mr. A Mutanga
School of Management Sciences
Business Management
University of Venda

Per email: MutangaA@tut.ac.za

31 August 2015

Dear Mr. Mutanga

**REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT UNIZULU "A CONTEXT-AWARE
BUSSINESS INTELLIGENCE FRAMEWORK FOR SOUTH AFRICAN HIGHER EDUCATION"**

Your email to me, dated 11 May 2015, refers.

I hereby grant approval for you to conduct part of your research at UNIZULU, as per the methodologies stated in your research proposal and in terms of the data collection instruments that you have submitted. I note also that the University of Venda has issued an ethical clearance certificate and having read the documentation, I am happy to accept that certificate.

You may use this letter as authorization when you approach the appropriate persons. Please note that permission is based on the documentation that you have submitted. Should you revise your research instruments, or use additional instruments, you must submit those to us as well.

I wish you well in your research.

Yours sincerely,



Professor Nokuthula Kunene

Chairperson: University of Zululand Research Ethics Committee

RESTRUCTURED FOR RELEVANCE



24 July 2015

Dr Alfred Mutanga
School of Management Sciences
TSHWANE UNIVERSITY OF TECHNOLOGY
Email: MutangaA@tut.ac.za

Dear Dr Mutanga

RE: PERMISSION TO CONDUCT RESEARCH

Gatekeeper's permission is hereby granted for you to conduct research at the University of KwaZulu-Natal (UKZN) towards your postgraduate studies, provided Ethical clearance has been obtained. We note the title of your research project is:

"A Context-Aware Business Intelligence Framework for South African Higher Education".

It is noted that you will be constituting your sample with a request for responses on the website. The questionnaire must be placed on the notice system <http://notices.ukzn.ac.za>. A copy of this letter (Gatekeeper's approval) together with the ethical clearance must be simultaneously sent to (govenderlog@ukzn.ac.za) or (ramkissoob@ukzn.ac.za). You are not authorized to distribute the questionnaire to staff and students using Microsoft Outlook address book.

Please ensure that the following appears on the questionnaire/attached to your notice:

- Ethical clearance number;
- Research title and details of the research, the researcher and the supervisor;
- Consent form is attached to the notice/questionnaire and to be signed by user before he/she fills in questionnaire;
- gatekeepers approval by the Registrar.

Please note that the data collected must be treated with due confidentiality and anonymity.

Yours sincerely



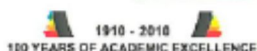
PROFESSOR D JAGANYI
REGISTRAR (ACTING)

Office of the Registrar

Postal Address: Private Bag X54001, Durban, South Africa

Telephone: +27 (0) 31 260 8005/2206 Facsimile: +27 (0) 31 260 7824/2204 Email: registrar@ukzn.ac.za

Website: www.ukzn.ac.za



Founding Campuses:  Edoewood  Howard College  Medical School  Pietermaritzburg  Wesville



Central University of
Technology, Free State

■ ACADEMIC PLANNING

Mr Alfred Mutanga

SCHOOL: MANAGEMENT SCIENCES

DEPARTMENT: BUSINESS MANAGEMENT

UNIVERSITY OF VENDA

MutangaA@tut.ac.za

**PERMISSION TO CONDUCT SURVEY AT CUT CAMPUS: "A CONTEXT-AWARE
BUSINESS INTELLIGENCE FREAMWORK FOR SOUTH AFRICAN HIGHER"**

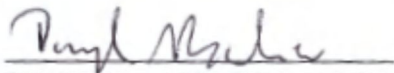
Dear Mr Alfred Mutanga

This is to confirm that you have been granted permission to conduct a survey for your PhD **"A CONTEXT-AWARE BUSINESS INTELLIGENCE FREAMWORK FOR SOUTH AFRICAN HIGHER"** on the CUT campus.

The conditions of the permission are:

- The survey will not interrupt any of the official activities at the CUT;
- You will supply us with the copy of your report;
- The cost of all related activities will be covered by yourself;
- Recruitment of participants is the sole responsibility of yourself;
- Voluntary nature of the potential participant's decision to consent to participate should be strictly observed;
- You should not disclose a potential participant's decision to participate or otherwise to any other party;

- Permission does not compel, in any sense, participation of staff members or students in your survey.



DIRECTOR: ACADEMIC PLANNING

DR DM BALIA

19 JUNE 2015



Research Ethics Committee

The TUT Research Ethics Committee is a registered Institutional Review Board (IRB 00005968) with the US Office for Human Research Protections (DHQ# 0004997) (Expires 9 Jan 2017). Also, it has Federal Wide Assurance for the Protection of Human Subjects for International Institutions (FWA 00011501) (Expires 22 Jan 2019). In South Africa it is registered with the National Health Research Ethics Council (REC-160509-21).

June 2, 2015

Ref #: REC/2015/04/001
Name: Mutanga A
Student #: 11641058, UNIVEN

Mr A Mutanga
Q/o Prof A Kadyamatimba
Department of Business Management
School of Management Sciences
University of Venda

Dear Mr Mutanga,

Decision: Final Approval

Name: Mutanga A

Project title: *A context-aware business intelligence framework for South African Higher Education*

Qualification: Doctor of Philosophy, Management Sciences, University of Venda

Supervisor: Prof A Kadyamatimba

Co-Supervisors: Prof N Mavetera & Dr JJ Zaaiman

Thank you for submitting the revised project documents for ethics clearance by the Research Ethics Committee (REC), Tshwane University of Technology (TUT). In reviewing the documents, the comments and notes below are tabled for your consideration, attention and notification:

- **Survey Cover Letter (Appendix A)**
 - The revised Cover Letter for an Anonymous Survey is in order and duly noted.
- **Survey Questionnaire (Appendix E)**
 - The revised survey questionnaire is in order and duly noted.



We empower people

- **Interviews**

- **Interview Data Collection Documents.** The REC took note of the indication (E-mail, dated 4 May 2015) that the originally planned interviews will no longer form part of the project.

- **Institutional Requirement**

- The REC took note of the commitment (E-mail, dated 4 May 2015) to provide a copy of the final project report to the TUT Director: Strategic Management Support, for notification and/or potential implementation in the TUT context.

An expedited review panel of the Research Ethics Committee (REC) of Tshwane University of Technology (TUT) reviewed the revised project document on June 1, 2015. **Final approval** is granted to the project. The decision will be tabled at the next REC meeting on June 22, 2015 for ratification.

The proposed research project may now continue with the proviso that:

- 1) The researcher/s will conduct the study according to the procedures and methods indicated in the approved proposal, particularly in terms of any undertakings and/or assurances made regarding the confidentiality of the collected data.
- 2) The proposal will again be submitted to the Committee for prospective ethical clearance if there are any substantial changes from the approved proposal.
- 3) The researcher will act within the parameters of any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.
- 4) The current ethics approval expiry date for this project is **December 31, 2017**. No research activities may continue after the ethics approval expiry date. Submission of a duly completed Research Ethics Progress Report (available at: <http://www.tut.ac.za/Other/rnnew/ResearchEthicsCommittee/Pages/default.aspx>) will constitute an application for renewal of SCRE ethics approval.

Note:

The reference number [top right corner of this communiqué] should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants.

Yours sincerely,



WA HOFFMANN (Dr)

Chairperson: Research Ethics Committee

[Ref# 2015=04=003=Mutanga A]



We empower people

University of Fort Hare

OFFICE OF UNIVERSITY REGISTRAR

Alice (main) Campus:

Private Bag X1314, King William's Town Road, Alice, 5700, RSA
Tel: +27 (0) 40 602 - 2501 • Fax: +27 (0) 40 602 - 2577
Email: nmabindisa@ufh.ac.za



September 01, 2015

Mr A Mutanga
School of Management science
Business Management
University of Venda

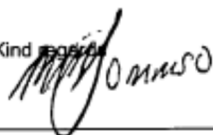
Dear Mr Mutanga

Approval from the Registrar's Office to conduct research

Having consulted the Chairperson of the Research Ethics Committee, I hereby grant permission for Mr A Mutanga to conduct research relating to her thesis "A Context –Aware Business Intelligence Framework for South African Higher Education".

We look forward to reading the research report.

Kind regards



Prof M M Somniso
REGISTRAR

Bhisho Campus:

P. O Box 1153, KWT 5600, Independence Avenue, Bhisho, 5600, RSA
Tel: +27 (0) 40 608 - 3407 • Fax: +27 (0) 40 608 - 3408

East London Campus:

Private Bag X9083, EL 5200, 50 Church Street, East London, 5201, RSA
Tel: +27 (0) 43 704 - 7000 • Fax: +27 (0) 43 704 - 7095
V/C Dial Up: +27 (0) 43 704 - 7143/ 7144

together in excellence



www.ufh.ac.za





10 July, 2015

Mr. A. Mutanga

Communications

Mr. A. Mutanga

It is my pleasure to inform you that permission to conduct survey titled: *"A context-aware Business Intelligence Framework for South African Higher Education"* amongst MUT staff members was granted.

Permission to conduct the survey is granted on the condition that any changes to the project must be brought to the attention of the MUT Research Ethics Committee as soon as possible.

Good luck with your research.

Yours sincerely,



Dr. Anette Mienie

Director: Research

031 9077354/7450

anette@mut.ac.za



University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 2212, Fax: (015) 268 2306, Email:noko.monene@ul.ac.za

**TURFLOOP RESEARCH ETHICS
COMMITTEE CLEARANCE CERTIFICATE**

MEETING: 02 September 2015

PROJECT NUMBER: TREC/167/2015: IR

PROJECT:

Title: A context-aware business intelligence framework for South African Higher Education

Researcher: Mr A Mutanga

Supervisor: Prof A Kadyamatimba

Co-Supervisor: Prof N Mavetera

Dr JJ Zaaiman

Institution: University of Venda

Degree: Independent Research


PROF. T. B. MASHEGO
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: REC-0310111-031

Note:

- i) Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee.
- ii) The budget for the research will be considered separately from the protocol.
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.



Tue 2015/09/29 16:02

Estie Emtoch <Estie.Emtoch@nwu.ac.za>

Ethics Clearance number - A Mutanga

To Nehemiah Mavetera

Good day Prof

Please find the Ethical Clearance number for:

A Mutanga - 11640358

Ethical Clearance number: NWU-00402-15-S9

I will forward you the Ethics certificate as soon as I receive it from Potchefstroom.

Hope you find this in order.

Kind regards

Estie Emtoch

Research Assistant

Office of the Executive Dean

Faculty of Commerce and Administration

Tel: (+27) 018 3892873

estie.emtoch@nwu.ac.za

MAFIKENG CAMPUS



NORTH-WEST UNIVERSITY
YUNIBESITHI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

F2 - Cover Letter



University of Venda

SCHOOL OF MANAGEMENT SCIENCES

DEPARTMENT OF BUSINESS MANAGEMENT

COVER LETTER – SURVEY ON BUSINESS INTELLIGENCE IN SOUTH AFRICAN HIGHER EDUCATION

PROJECT TITLE: A CONTEXT-AWARE BUSINESS INTELLIGENCE FRAMEWORK FOR SOUTH AFRICAN HIGHER EDUCATION

Primary investigator: Mr A Mutanga, MSc, PhD Candidate

Study leader: Prof A Kadyamatimba, PhD, Department of Business Information Systems, University of Venda, Thohoyandou,

Co-Study Leader: Prof N. Mavetera, PhD, Faculty of Commerce and Administration, School of Economics and Decision Sciences, North-West University, Potchefstroom,

Co-Study Leader: Dr J. J. Zaaiman, PhD, Department of Business Information Systems, School of Management Sciences, University of Venda, Thohoyandou

Dear Potential research participant,

You are invited to complete an online survey questionnaire that forms part of my formal doctoral studies in the Department of Business Management, in the School of Management Sciences at the University of Venda.

This research study, aims to address and put into practice the theoretical foundations of information systems research and develop a Context-Aware Business Intelligence Framework in order to respond to institutional decision making activities within the South African Higher Education sector. The study intends to address the loopholes in managing Higher Education institutions by fact and also streamline how integrated business intelligence tools and applications can bring organizational intelligence.

If you decide to take part in the study, you will be required to complete the on-line Survey on Business Intelligence in South African Higher Education Institutions, with link <http://alflearn.co.za/lime/index.php/977169/lang-en> . You will be asked to respond to questions regarding the business intelligence system being used at your institution, methodologies used to implement the business intelligence systems, business and technology alignment, organizational strategies in implementing business intelligence solutions, including questions related to technology strategies within your institution. It should not take more than 30 minutes of your time to complete it.

You will not be eligible to complete the questionnaire if you don't have a sound background in information systems, particularly decision support systems. This survey requires you to have a background in information systems development methodology, management information systems and a good understanding of business and information technology alignment principles.

In the survey you will be requested to share your own personal opinions about the business intelligence systems implementation at your institution. This information will be treated with strict confidentiality to avoid any damage to your institution including any member of staff or management.

The survey items have been drafted in such a way that they don't elicit information from any unit records from staff or students at your institution.

The results of the questionnaire will have no direct personal benefits to you, but you will make a contribution towards a better understanding of what constitutes a methodological approach in implementing business intelligence systems, within the South African Higher Education Sector. Your participation in this study is entirely voluntary and anonymous. You have the right to withdraw at any stage without any penalty or future disadvantage whatsoever. You don't even have to provide the reason/s for your decision. Your withdrawal will in no way influence your continued relationship with the research team. Note that you are not waiving any legal claims, rights or remedies because of your participation in this research study. All information obtained from the questionnaire is strictly confidential.

All the data that you provide in the survey will be handled confidentially. This means that access to your data will be strictly limited to the researcher, the supervisors of the study and the designated examiners appointed by the University of Venda. Also, your questionnaire responses and personal information will be kept and stored in a confidential format that will only be accessible to the researcher. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. The results of this study might be published in a scientific journal and/or presented at scientific meetings, but again without revealing the identity of any research participant. The original questionnaires will be stored in a safe place for three years, after which they will be destroyed. It is also noteworthy there will be no collection of any IP address of the computing equipment you have used to answer the survey.

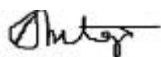
The Research Ethical Clearance Committee of the University of Venda have approved the formal study proposal. The ethics clearance number is Ref #: SMS/14/BMA/01/1411. Also, the University Higher Degrees Committee at the University of Venda have given a written approval of the study. It is important to note that all parts of the study will be conducted according to internationally accepted ethical principles.

The primary investigator, Mr A Mutanga, can be contacted during office hours at Tel (012) 382-4343, or on his cellular phone at 083 712-4553. The study leader, Prof A Kadyamatimba, can be contacted during office hours at Tel (015) 962-8706. Should you have any questions regarding the ethical aspects of the study, you can contact the chairperson of the UNIVEN Research Ethical Clearance Committee, Prof G E Ekosse, during office hours at Tel (015) 962-8816/8313, and his electronic mail address is Georges-Ivo.Ekosse@Univen.ac.za.

The Research and Publication Committee at the University of Venda has allocated a sponsorship to the value of R75 000-00 to the study. Additionally, the primary investigator had received software tools worth R71 625.00 from Ramsden Trading: IDSC to implement at the University of Venda. The final results of the study will only be published after the Chairperson of the University Higher Degrees Committee at the University of Venda has given written approval of the research report. A copy of the final approved project report will also be provided to the TUT Director: Strategic Management Support.

Your participation in the study will be greatly appreciated.

Yours sincerely



Alfred Mutanga
(PhD Candidate)

F3- Editing Report

This letter serves to confirm that I, Dr I. Ndlovu of the English Department, University of Venda, have proofread and edited the PhD thesis titled “**A Context-Aware Business Intelligence Framework for South African Higher Education Institutions**” by Alfred Mutanga (Student No: 11640358), a research thesis submitted in the fulfilment of the requirements for the degree of Doctor of Philosophy, Department of Business Management, School of Management Sciences, University of Venda.

I carefully read through the thesis, focusing on proofreading and minor editorial issues. The recommended changes were clearly highlighted and Alfred could either accept or reject the changes using the Track Changes function in Microsoft Word.

Yours Sincerely



Dr Isaac Ndlovu, PhD
Lecturer: English Department
University of Venda
Private Bag X5050
Thohoyandou 0950
South Africa
Tel.: +27 15 962 8579
Fax: +27 15 962 4749
E-mail: isaac.ndlovu@univen.ac.za