Usability guidelines for business intelligence banking reports: a mixed methods study in the South African banking industry

by

PHELADI ANNAH LEBOTSA

submitted in accordance with the requirements
for the degree of

MASTER OF SCIENCE

in the subject

COMPUTING

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF JA VAN BILJON

CO-SUPERVISOR: DR R VAN DER MERWE

FEBRUARY 2024

DECLARATION

Name: Pheladi Annah Lebotsa

Student number: 56344589

Degree: Master of Science in Computing

USABILITY GUIDELINES FOR BUSINESS INTELLIGENCE BANKING REPORTS: A MIXED METHODS STUDY IN THE SOUTH AFRICAN BANKING INDUSTRY

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USABILITY GUIDELINES FOR BUSINESS INTELLIGENCE BANKING REPORTS: A MIXED METHODS STUDY IN THE SOUTH AFRICAN BANKING INDUSTRY

ABSTRACT

Business intelligence (BI) reports are vital for the success of the banking industry, since these reports give data-based insights to the end-user groups from different business units to inform operational, strategic and tactical decisions. The problem is that these BI reports are often not used. The adoption and optimal use of these reports depend on various factors, one of those being usability. Besides the business problem observed by the researcher as an employee of a big South African bank, published research on the usability of BI banking reports is lacking. For this reason, this study investigated and identified the critical usability criteria that should be used to evaluate BI banking reports. The research was guided by the question: What are the critical usability criteria that should be used to evaluate the BI banking reports? The research design for the study employed mixed methods, with pragmatism as the guiding philosophy. The BI usability criteria were identified in the literature and used as the basis for designing the research instruments, which included a survey and interviews with employees, all of whom were BI users in a South African bank. In addition to the primary data gathered from these employees, company issue log data was obtained from a bank portal that documented usability issues reported by the same BI users involved in the empirical data collection process. The literature-based usability criteria were compared with the findings gleaned from the bank portal analysis and the survey, respectively to propose two sets of criteria. These sets of usability criteria for BI banking reports were triangulated with the findings of the analysis of the interview data to produce the critical usability criteria for BI banking reports (final set of criteria). The theoretical contribution of the study is the evidence-based, critical usability criteria for BI banking reports. These usability criteria address the gaps in the existing knowledge concerning the usability of BI reports in the banking industry. On a practical level, the criteria can be used to better understand and optimise the use of business intelligence banking reports.

Keywords: Business intelligence (BI), BI reports, banking, usability criteria, user experience

Acknowledgements

I would like to convey my heartfelt gratitude to my supervisors, Prof. Judy van Biljon and Dr Ronell van der Merwe, for becoming my mentors. Your approach, advice and empowerment were remarkably helpful.

I am thankful to all the participants who gave of their time voluntarily and assisted in the data collection process. My thanks also go to my employer who gave me the permission to conduct the study at the bank.

I would also like to thank my husband, my children and my brother for the support, understanding and patience they showed me during these challenging times. Above all, a special thanks to the God of Mount Zion for the power and possibility of making this study a success and a complete product.

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LIST OF ABBREVIATIONS AND ACRONYMS

Acronym	Meaning
ABSA	Amalgamated Banks of South Africa
ACM	Association for Computing Machinery
AI	Artificial Intelligence
BA	Business Analytics
BI	Business Intelligence
BIBRUC	Business Intelligence Banking Reports Usability Criteria
BIBRUCUP	Business Intelligence Banking Reports Usability Criteria from a User's Perspective
BIS	Business Intelligence Systems
CBIBRUCUP	Critical Business Intelligence Banking Reports Usability Criteria from a User's Perspective
CBR	Case-Based Reasoning
CIL	Company Issues Log
COVID-19	Coronavirus Disease-2019
CRM	Customer Relationship Management
CSET	College of Science, Engineering and Technology
DSS	Decision Support System
DW	Data Warehouse/Warehousing
EHR	Electronic Health Records
EIS	Executive Information System
ERAS	Enterprise Reporting and Analysis System
ERP	Enterprise Resource Planning
ETL	Extract, Transform and Load
GSS	Group Support System
HCI	Human–Computer Interaction
ICT	Information and Communication Technology
IDSS	Intelligent Decision Support Systems
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IEEE std	Institute of Electrical and Electronics Engineers Standard
InKoM	Intelligent Dashboard for Managers
IS	Information System
ISO	International Standards Organisation

Acronym	Meaning
ISO FDIS	International Standard Organisation Final Draft International Standard
IT	Information Technology
KMDSS	Knowledge management-based decision support systems
KPI	Key Performance Indicator
LBUC	Literature-Based Usability Criteria
MMR	Mixed Methods Research
MS	Microsoft
MSC	Master of Science in Computing
MTECH	Master of Technology
NLR	Narrative Literature Review
NSS	Negotiation Support System
OLAP	Online Analytical Processing
PDSS	Personal Decision Support System
POPIA	Protection of Personal Information Act
ResQue	Recommender Systems' Quality of User Experience
RQ	Research Question
RSQ	Research Sub-Questions
SA	South Africa/South African
SIG	Special Interest Group
SLR	Systematic Literature Review
SoC	School of Computing
SPSS	Statistical Package for Social Sciences
SQL	Structured Query Language
SSIS	Structured Query Language Server Integration Services
SSRS	Structured Query Language Server Reporting Services
TA	Thematic Analysis
TOP	Technical, Organizational, and Process
UNISA	University of South Africa
UX	User experience
XAI	Explainable Artificial Intelligence

CHAPTER 1 : INTRODUCTION

1.1. Background to and the Rationale for the Study

South African (SA) banks rank among the largest banking corporations on the African continent (Smith, 2021). According to Matemilola et al. (2015), the SA banking sector is renowned as world class, boasting ample capital, cutting-edge technology, robust infrastructure, and a rigorous regulatory and supervisory framework. The prominent banks in SA encompass the Amalgamated Banks of South Africa (ABSA), the Standard Bank Group, the Nedbank Group, and FirstRand Bank (Ramavhona & Mokwena, 2016; Smith, 2021). The provision of banking services in the SA region is of significant importance, catering to a diverse range of businesses', consumers' and investors' needs (Smith, 2021). The banking industry plays a vital role in the SA economy (Moro et al., 2014) and thrives within a dynamic market propelled by customer demands (Rezaie et al., 2018) and competition (Moro et al., 2014; Rezaie et al., 2018). The banking sector delivers various services to customers (Al Karim & Chowdhurry, 2014), including loans, deposit management and investment in capital markets (Moro et al., 2014), strategically engaging with customers' funds (Al Karim & Chowdhurry, 2014). To fulfil these services, the banking industry requires pertinent and timely information to adapt to the challenges inherent in its intricate and dynamic environment (Rezaie et al., 2018).

Organisations consistently seek to extract value from their expanding data assets to gain or uphold competitive advantages (Lautenbach & Johnston, 2017). This principle also applies to the banking industry. In order to not only weather the challenges of today's turbulent business landscape but also to thrive, the industry has to continuously address intricate problems and seize opportunities. This emphasises the importance of robust decision support systems (DSSs) and business intelligence systems (BIS) (Moro et al., 2014).

A DSS is an information system (IS) that is considered to be a support system for businesses and organisations when it comes to making decisions (Arnott & Pervan, 2012; Dulcic et al., 2012; Hart & Gregor, 2010). A DSS can assist in gathering relevant data from a variety of sources, including unprocessed data, documents, individual experience and/or models (Van der Spiegel et al., 2013), to allow users to analyse a situation (Brijs, 2012; Grigera et al., 2018). Arnott and Pervan (2012) categorised BIS as enterprise reporting and analysis systems (ERASs) in DSSs. For this study, a BIS is considered to be a category of DSSs. Business intelligence (BI) is often used as an umbrella term for a broad category of technologies, tools, applications and processes that facilitate the collecting, storing, accessing, analysing and reporting of data across an organisation to assist its users in making better decisions (Moro et al., 2015; Narang, 2023; Parthasarathy, 2010; Sarma, 2021; Valdez et al., 2017; Wixom &

Watson, 2010). BI plays a pivotal role in extracting information from data clutter that could be useful for reporting and decision-making purposes (Venter & Tustin, 2009). Furthermore, BI primarily focuses on improving the timeliness and quality of information, whilst enabling managers to understand their firm's competitive position (Khan & Quadri, 2012).

Munoz (2017) proposes two perspectives on BI, the first of which views BI as a broad perspective which comprises all of an organisation's data collection activities. The second is a narrow perspective that entails the information technology (IT) angle associated with software services. In the literature the terms BI and BIS are often used interchangeably, so it is not always possible to disambiguate their perspectives. In this dissertation the term BI refers to the broad perspective where the goal is to improve the timeliness and quality of the business-related information. The term BIS will be used when referring only to the IT perspective. Informed decision-making within the banking sector necessitates BI, which facilitates the transformation of data into actionable insights that are instrumental in making astute business choices (Hočevar & Jaklič, 2010). BI empowers companies to fathom their inherent nature and their operational efficiency, and assists in formulating a strategy harmonious with their organisational context, ensuring that implementation paves the way for sound decisions that enhance overall performance (Nithya & Kiruthika, 2021); thereby, collecting information from internal and external data sources, preparing data for analysis, running queries and creating intuitive visualisations, reports and dashboards (Tikait, 2023).

Within the realm of BI, there exist several distinct processes, concepts and components that collectively enhance an organisation's decision-making capabilities. To elucidate their interrelations, consider Figure 1.1, which shows sub-themes within processes, concepts and components. Processes are a crucial component of BI; therefore, there have to be processes in place for storing data in the data warehouse (DW); loading data, be it real-time or historical, by filtering out irrelevant information; and depicting analysis by maintaining metadata (Wixom & Watson, 2010). There are four key concepts of BI, namely, data collection (which involves the extraction of data and consolidating the data into the DW), analysis (which involves accessing and analysing data), visualisation (which involves the creation of reports and dashboards) and decision-making (Xlogiatech, 2023). The components of BI are essential for virtually facilitating decision-making (Bharadiya, 2023). Key components of BI include DW, data sources, data mining, extract, transform and load (ETL), and online analytical processing (OLAP) (Wixom & Watson, 2010).

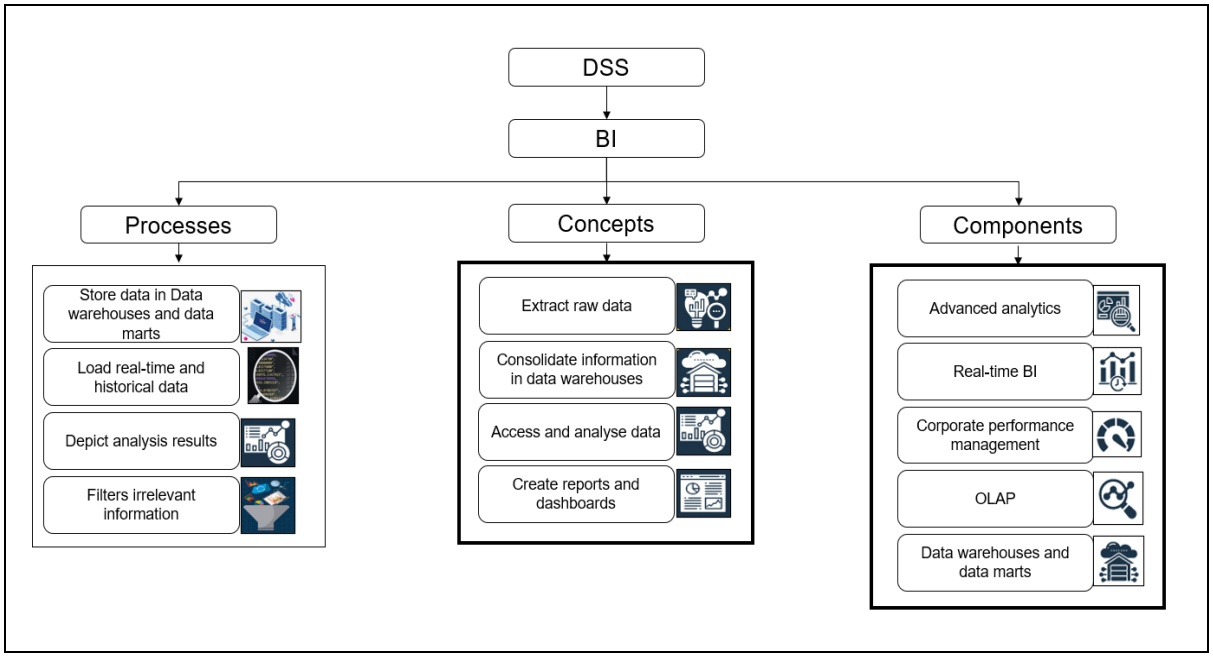

Figure 1.1: BI Processes, Concepts, and Components (Created by Author)

The adoption of BI tools is paramount in order for enterprises to make well-informed business decisions (Quamar et al., 2020). BI tools facilitate access and delivery, as well as the visual representation of, information from the organisation's data to business users (Sherman, 2014). BI tools enable users to interact with data and glean insights by means of various methods. Figure 1.2 gives an example of a BI front-end access point, which is used by the users to access and extract data from the DW using BI tools. Among the tools available in BI for producing end-user queries and reporting are OLAP, dashboard tools, data mining tools (Ghazanfari et al., 2011), reporting tools and catalogue tools.

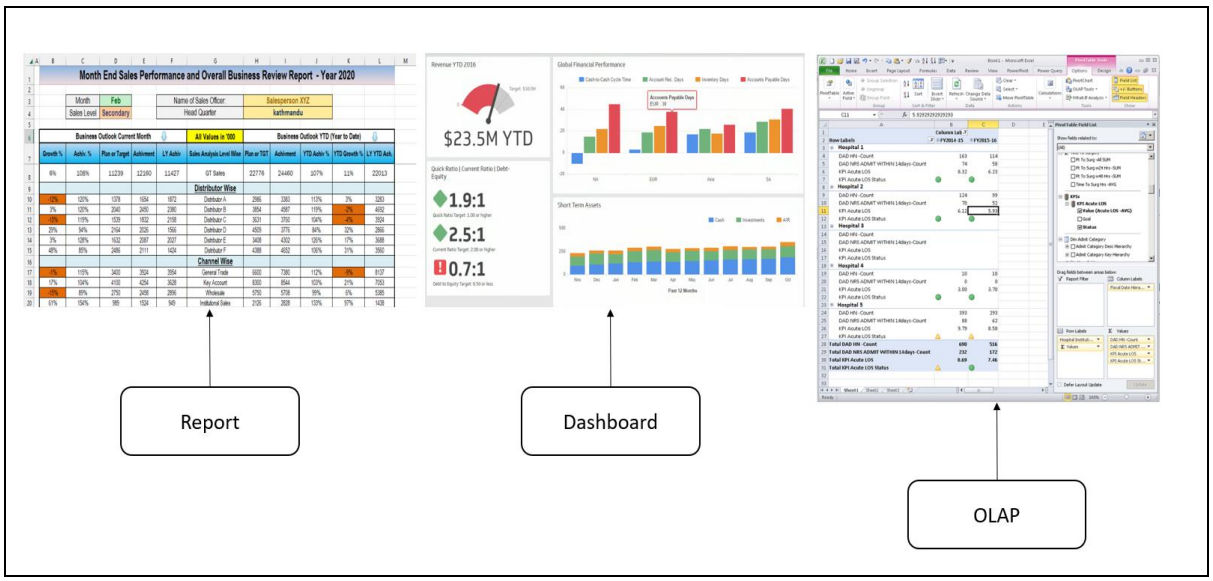

Figure 1.2: An example of a BI front-end access point (Created by Author)

Using tools such as OLAP, BI enables users to access diverse datasets, consolidate vast amounts of information, conduct analyses and visualise data in an easily digestible format (Wise, 2012). BI dashboards, a subset of BI tools, offer a mechanism for business owners and executives to explore data through visual interfaces (Quamar et al., 2020). BI dashboards condense performance metrics into more understandable visualisations (Hansoti, 2010). For instance, utilising OLAP, data is presented in data cubes, fostering quick analysis by transforming raw data into a comprehensible format (Jinpon et al., 2011).

BI reports play a pivotal role in BI. Organisations employ reports to identify performance trends and financial anomalies (Wise, 2012). To maintain competitiveness, interactive reports with drill-through capabilities and dashboard visualisations are essential (Wise, 2012). Data mining is a process where one or several algorithms are used to identify interesting trends and patterns within the data (Roiger, 2017). According to Oracle (2011), catalogues are used to store and group objects in a folder for easy access. Catalogues perform a similar function to folders on a desktop.

A more detailed discussion of BI, BIS, DSS and the related concepts, processes and components is provided in Chapter 2.

BI projects encompass the implementation of BI solutions, which involve the design, development and deployment of BIS that are specifically tailored to meet an organisation's needs. However, a significant percentage of BI projects fail (Ain et al., 2019); notably, between 60 and 70% (Olszak, 2016). Isik et al. (2011) suggest that these failures occur when organisations decide to adopt BI without a clear understanding of the critical capabilities that define the success of such applications. The failure of BI projects indicates that organisations encounter challenges beyond straightforward software and hardware implementation, since these projects are complicated to deploy and manage (Lautenbach & Johnston, 2017).

According to Gartner (2022), the reasons for BI project failure include (1) a lack of understanding about how BI should serve the business, and (2) the failure of IT and commercial departments to speak a common language. Furthermore, despite technological advances which make BI easier to use, and despite many organisations recognising the value of analytics and investing in both the tools and the BI literacy programmes to train their employees on how to use the data, the rate of BI adoption in organisations remains largely stagnant (Avidon, 2023). The adoption and usage of BIS depend on a network of interconnected factors, with usability being pivotal. Usability is the study of the intersection of between systems and users, tasks and expectations in the context of use (Weichbroth, 2020). Usability significantly influences the acceptance of BIS by ensuring ease of use and learning (Thowfeek & Salam, 2014). Furthermore, usability plays a crucial role in interacting with user

interfaces, enabling users to access information and generate outputs (Shitkova et al., 2015). Criteria that have an impact on the usability of BIS encompass learnability (Brosens et al., 2018; Myers & Stylos, 2016), robustness (Brosens et al., 2018; Dyczkowski et al., 2014), design consistency (Brosens et al., 2018), and flexibility (Brosens et al., 2018; Jooste et al., 2018; Smuts et al., 2015).

The remainder of this chapter is structured as follows: section 1.2 elucidates the problem statement underpinning this study, section 1.3 introduces the research questions, while section 1.4 outlines the study objectives. Section 1.5 details the research design and methodology employed in this study, section 1.6 presents the ethical clearance procedure, section 1.7 delineates the research process, while section 1.8 discusses the scope and limitations of the study. Section 1.9 highlights the significance of the study and, finally, section 1.10 concludes with a graphic representation of the chapter layout.

1.2. Problem Statement

BIS enable users to harness insights generated from diverse data sources for management, visualisation, summarisation and informed decision-making (Antoniadis et al., 2015). Within the banking context, BI solutions should empower decision-makers across various business segments, enabling efficient information management and utilisation. Ideally, BI should facilitate rapid computation, improve communication and collaboration, as well as heighten team productivity, effective data utilisation and ubiquitous support (Nithya & Kiruthika, 2021).

BI adoption in organisations stands at somewhere between 25 and 35% of employees (Avidon, 2023). As mentioned, between 60 and 70% of BI projects result in failure (Ain et al., 2019; Olszak, 2016). Notably, the primary reason for the failure of BI projects is the lack of user adoption (Ain et al., 2019; Manuel et al., 2017).

The failure of BI projects occurs when organisations adopt BI without a clear understanding of the critical capabilities that define the success of BIS (Isik et al., 2011). While several factors contribute to the underutilisation of BIS, usability is a significant determinant of successful adoption (Antoniadis et al., 2015; Popovič et al., 2012). If a product is not effective or efficient and cannot be used with satisfaction, users tend to gravitate towards more usable alternatives (Tullis & Albert, 2008).

The banking industry, specifically, faces a substantial challenge in the underutilisation of BI reports (Audzeyeva & Hudson, 2016). In the bank at which this study was conducted, there is a portal to capture issues the users experienced when using the BI reports. For the purposes of this study, this portal will be referred to as the company issues log (CIL). The business problem identified in this study stems from the issues reported by the users on the CIL.

Despite the abundance of usability publications, gaps persist in the realm of usability criteria for BI (Jooste et al., 2014; Scholtz et al., 2016; Smuts et al., 2015). While several studies have investigated usability criteria, they have not done so within the banking industry context. The identified studies include works by Jose (2016) in the special interest group (SIG) context, Malinga et al. (2013) in the mashups context, Nithyanand et al. (2010) in the secure device association context, and Pu and Chen (2011) in the recommender systems' quality of user experience (ResQue) context. There are many usability attributes to consider in order to make the design and evaluation of the BIS efficient. Therefore, it is necessary to prioritise and identify the critical criteria for the application area. The research problem can thus be summarised as a gap in the literature on usability criteria for BI in the banking industry, specifically the critical usability criteria for BI banking reports.

1.3. Main Research Question

The main research question (RQ) that will guide this study is formulated as follows:

RQ: What are the critical usability criteria that should be used to evaluate the BI banking reports?

1.3.1. Research Sub-question

The main RQ is supported by the following research sub-questions (RSQ) as presented in Table 1.1, alongside the corresponding research actions:

Table 1.1: Research Sub-questions (RSQ)

RSQ	Research Sub-question	Research Action
RSQ1	What criteria are available to evaluate the usability of BI reports?	Conduct a narrative literature review (NLR) followed by a systematic literature review (SLR) to develop a list of *literature-based usability criteria* (LBUC).
RSQ2	What are the usability issues of BI reports in the banking industry?	Identify usability issues in relation to BI reports derived from CIL and synthesise the LBUC by considering the following: • Capture BI report usability issues from the CIL. • Perform CIL data extraction and data analysis to identify usability issues based on the data captured.

RSQ	Research Sub-question	Research Action
		• Synthesise usability criteria for BI banking reports by comparing the usability issues identified from the CIL with the LBUC in order to identify BI banking report usability criteria (BIBRUC).
RSQ3	What are the usability criteria that should be used to evaluate the BI banking reports from the user's perspective?	Conduct survey based on LBUC to evaluate the BI banking report usability criteria from a user's perspective (BIBRUCUP) and to present a list of such criteria.
RSQ4	What are the critical usability criteria that should be used to evaluate the BI banking reports from the user's perspective?	Conduct interviews based on BIBRUC and BIBRUCUP to evaluate the perspective in this regard and to present a final list of critical BI banking report usability criteria (CBIBRUC).

1.4. Objective of the Study

The main and sub-objectives of this study are presented as follows:

1.4.1. Main Research Objective

The study aims to investigate and identify the critical usability criteria that should be used to evaluate BI banking reports.

1.4.2. Research Sub-objectives

The following sub-objectives were formulated for this research:

- To identify the criteria that are available to evaluate the usability of BI reports.
- To identify the BI reports' usability issues in the banking industry.
- To identify the usability criteria that should be used to evaluate the BI banking reports from the user's perspective.
- To identify the critical usability criteria that should be used to evaluate the BI banking reports from the user's perspective.

1.5. Research Design and Methodology

The literature review is conducted in order for the researcher to become aware of existing knowledge in the discipline of interest, to interpret what is already known, and ultimately, to point out the inconsistencies and gaps in the existing literature (Jesson et al., 2011). According

to Paré and Kitsiou (2017), and Yang and Tate (2012), different types of literature review exist which include, among others, narrative, systematic and aggregative reviews. The current study adopted an NLR and an SLR. An NLR may be considered to be a qualitative method that applies a traditional review of existing and previous academic research to understanding the relationships between concepts (Yang & Tate, 2012). An SLR is a systematic review of the scholarly literature on a research topic that critically analyses, evaluates and synthesises findings, theories and practices by scholars and researchers related to an area of focus (Efron & Ravid, 2018).

The worldview employed in this study is that of pragmatism. Pragmatism focuses on solving practical problems (Creswell, 2013; Wheeldon, 2010) so the debate about the existence of objective “truth”, or the value of subjective perceptions, becomes less important (Wheeldon, 2010). Pragmatists focus on what works (Creswell, 2013). Since pragmatism opens the door to multiple methods, as well as different forms of data collection and analysis (Creswell, 2014), it aligns well with the mixed methods research (MMR) strategy followed in this study.

MMR is more than simply collecting multiple forms of qualitative evidence (such as observation and interviews) or quantitative evidence (such as surveys and diagnostic tests) (Klassen et al., 2012). Rather, MMR involves the intentional collection of both quantitative and qualitative data, and the combination of the strengths of each, to answer research questions (Creswell, 2014; Klassen et al., 2012). Accordingly, the study employed both quantitative and qualitative data-capturing strategies. Quantitative research approach comprises the act of gathering and evaluating statistical information objectively to describe, predict or regulate aspects of concern (Mcleod, 2019). Thus, quantitative methods are based on statistics or numerical ways of presenting data. In this case, a survey was used to acquire the quantitative data. In contrast, qualitative research approaches are used to understand people's beliefs, experiences, attitudes, behaviour and interactions (Vibha et al., 2013), and are concerned with the subjective assessment of attitudes, opinions and behaviour (Kumar, 2014). In this study, interviews and CIL data extraction and data analysis were used to capture the qualitative data.

1.6. Ethical Clearance Procedure

To ensure ethical compliance, the researcher had to adhere to the University of South Africa (Unisa) policy on research ethics (UNISA, 2005). The researcher informed the organisation investigated in this study of the intention to perform the study in the organisation, and submitted a letter to the organisation for clearance once permission was obtained. The feedback was then included in the ethical clearance form that was submitted to Unisa to obtain the certification of ethical compliance from the Research Ethics Committee of Unisa’s School of Computing (SoC) (Ref: 2020/CSET/SOC/031). When the ethical clearance was received,

the study was still classed as being conducted to obtain an MTech degree; this was later converted to an MSC. The ethical clearance certificate is attached as Appendix A. A consent form (see Appendix B) was signed by the participants to indicate their agreement to participate in the study.

1.7. Research Process Flow

The research process for this study is illustrated in Figure 1.3. This research diagram shows the sequence of processes within the study. The objects represent the actions listed below:

- Object 1 – The research problem was identified and the research questions were formulated.
- Object 2 – The literature review was conducted.
- Object 3 – The narrative literature review (NLR) was conducted.
- Object 4 – The systematic literature review (SLR) was conducted.
- Object 5 – The BI concepts formed the output from the NLR.
- Object 6 – The usability concepts formed the output from the NLR.
- Object 7 – The usability concepts formed the output from the SLR.
- Object 8 – The synthesis of the findings of the literature-based usability concepts produced the LBUC.
- Object 9 – The survey questions formulated, based on the LBUC, were sent to BI users at the bank (survey participants) to identify BIBRUC from a user's perspective (BIBRUCUP).
- Object 10 – The CIL data was extracted from the company portal, to identify the BI banking reports usability issues. The BI banking reports usability issues, where then mapped to the LBUC to identify the business intelligence banking reports usability criteria (BIBRUC).
- Object 11 – The statistical data analysis was performed to evaluate the survey results. The findings from the survey identified the BIBRUCUP.
- Object 12 – The thematic analysis (TA) was performed to evaluate the CIL data extraction. The usability issues related to BI banking reports were mapped to the LBUC and a list of BIBRUC was identified.
- Object 13 – The interview questions based on objects 11 and 12 were formulated in order to identify the CBIBRUCUP.
- Object 14 – A thematic analysis (TA) was performed to evaluate the interviews. The usability issues related to BI banking reports were mapped to the BIBRUC and BIBRUCUP and a list of CBIBRUCUP was identified.

Object 15 – The results for the surveys (BIBRUCUP), CIL data extraction (BIBRUC) and interviews (CBIBRUCUP) were integrated.

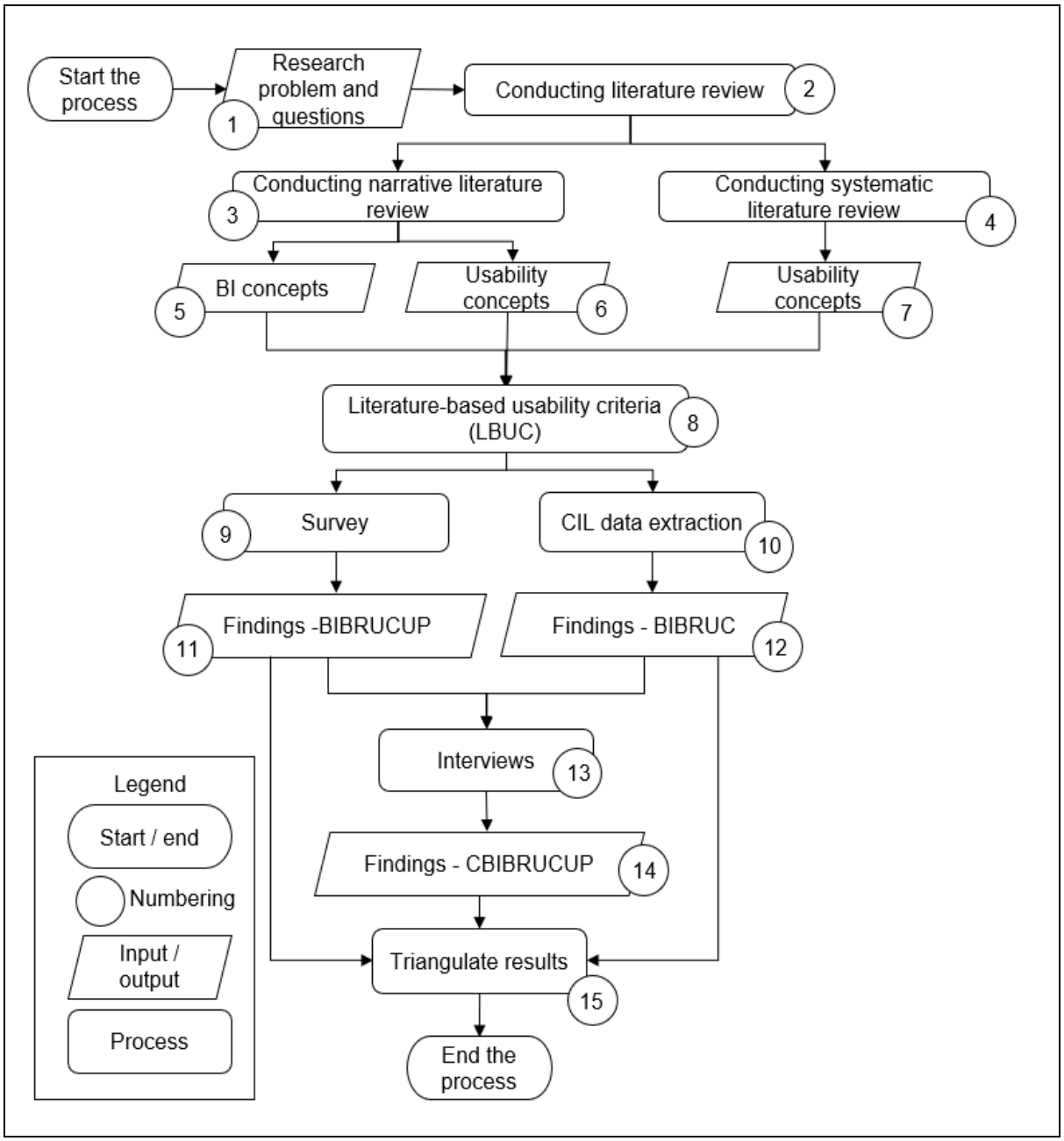

Figure 1.3: Research Process Flow (Created by Author)

1.8. Scope and Limitations

This section discussed the scope and the limitations of the study.

1.8.1. Scope of the Study

The scope of this study can be described as follows:

- This is a cross-sectional study, which is characterised by the collection of relevant information (data) at a given point in time, as advocated by Kesmodel (2018). This data is based on the sub-population of one of the big four SA banks.
- The present study focused only on the identification of critical business intelligence banking reports usability criteria from a user's perspective (CBIBRUCUP) at one of the big four banks in SA. Further studies might focus on engaging with multiple banks in SA.
- To protect the name of the bank used for the study and ensure confidentiality, aliases were used in instances where the names of the product and services were shown on the document. During the ethical clearance application with the bank, it was agreed that the data should not in any way reveal the bank's name, owing to certain legal factors and the potential loss of it operating licence, among others.
- The study was limited to employees who were using and developing BI reports.
- The data collection method was based on a survey, CIL data extraction and interviews. Further studies might focus on other data collection methods such as focus groups.

1.8.2. Limitations of the Study

The limitations of this study include the following:

- The bank employees who were sampled for the study might not fully represent the population.
- Only one bank was used for this study.
- The study considered a limited target population of 250, which covered one business unit and not the entire organisation.

1.9. Significance of the Study

The set of CBIBRUCUP developed in this study contributes to addressing the lack of published usability criteria for BI reports in the banking industry. On a practical level, the CBIBRUCUP may assist in the overall assessment of the BI reports. Furthermore, the results of this study may contribute to an understanding of BI reports in the banking sector and the improvement of BI usability in the financial services sector.

1.10. Layout of the Chapters

This study consists of seven chapters; the current chapter serves as an introduction, describing the problem statement, research questions and research objectives. Additionally, Chapter 1 outlines the purpose, contributions and scope of the study, as well as the research design and methodology applied. Chapter 2 provides the core concepts related to BI based on an NLR. In Chapter 3, a review of the literature explores usability and its pertinent criteria, shedding light on the study context.

Chapter 4 presents the research design and methodology adopted for this study, Chapter 5 presents the findings derived from the collected and analysed data for the survey and data extracted from the CIL, while Chapter 6 presents the findings derived from the data collected and analysed during the interviews. Given the utilisation of these two distinct methods of data collection, the results are triangulated to contrast and confirm the study conclusions. A survey, interviews and data extracted from the CIL were employed to ensure the collection of comprehensive data.

In Chapter 7, the study findings are discussed, highlighting key insights and contributions. The chapter also acknowledges the limitations of the study and makes recommendations for future research directions. The composition of these chapters is illustrated in Figure 1.4, which provides a visual overview of their interconnected structure.

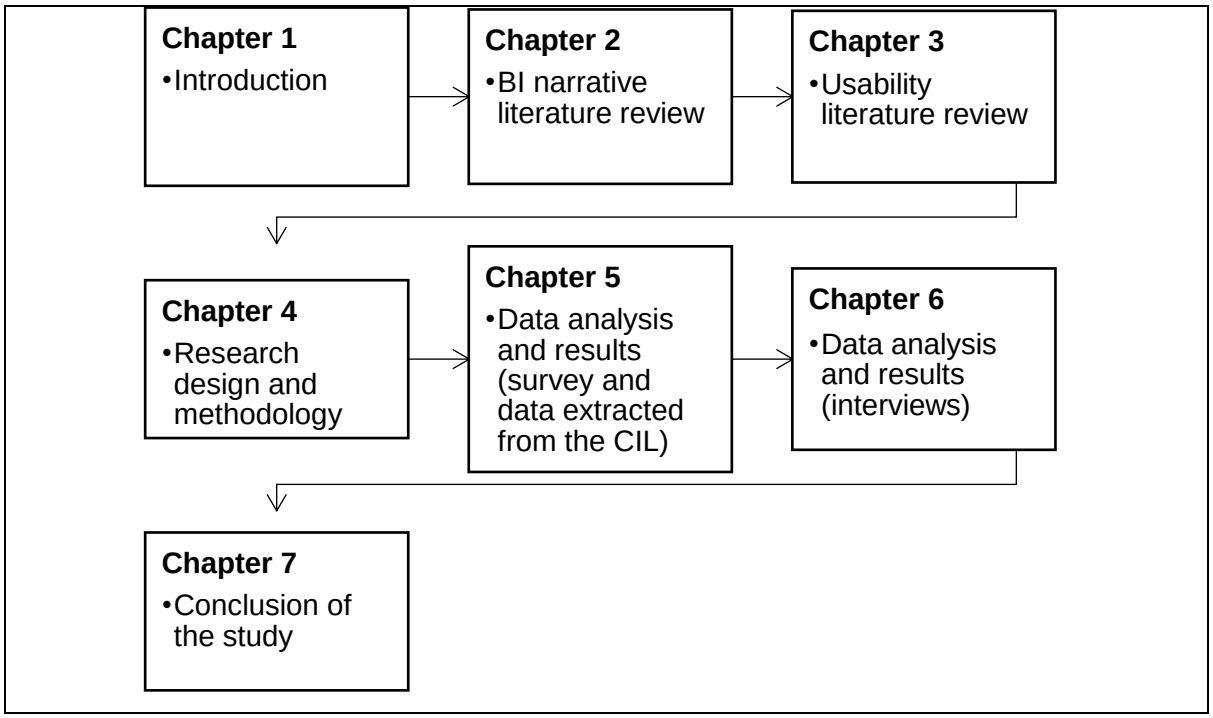

Figure 1.4: Chapter Layout

CHAPTER 2 : BUSINESS INTELLIGENCE CONCEPTS – NARRATIVE LITERATURE REVIEW

2.1. Introduction

Chapter 1 provided an introduction to and the rationale for this study. This included a brief description of the research questions, problem statement and scope, as well as the proposed research design and methodology. This chapter introduces business intelligence (BI) through a narrative literature review (NLR), providing a comprehensive and interpretive summary of the available literature in the field. Firstly, the context for BI within decision support systems (DSSs) is discussed in section 2.2. BI is then defined and investigated in terms of its purpose in section 2.3. The components of BI are presented in section 2.4, while BI applications are presented in section 2.5. BI reporting within the banking context with the aim of making decisions is discussed in section 2.6. The chapter concludes with a summary in section 2.7.

2.2. BI Within the Context of Decision Support Systems

2.2.1. Decision Support Systems

A decision support system (DSS) is a set of related computer-based applications that combines data and mathematical models to help decision-makers solve complex problems in managing public and private enterprises and organisations (Asemi et al., 2011; Demigha, 2021; Kanatas et al., 2020; Sauter, 2014; Vercellies, 2011). Early DSS efforts aimed to integrate advancements in database management with management science and decision analysis, contributing to real decision problem analysis (Hosack et al., 2012). While acknowledging that DSSs do not provide a panacea for all organisational challenges, their effectiveness lies in addressing specific problems (Sauter, 2014). Table 2.2 outlines accepted DSS technology goals by Sauter (2014) and proposed characteristics by Asemi et al. (2011), offering a comprehensive view of DSS objectives and features. In the realm of information systems (ISs), DSSs entail a discipline that focuses on systems designed to support and improve managerial decision-making (Arnott & Pervan, 2012; Dahr et al., 2022; Hart & Gregor, 2010; Jung et al., 2020). Arnott and Pervan (2012) identified seven DSS types, of which they incorporate technology, theory foundations, user populations and decision tasks, distinguished by their release dates (see Table 2.1).

DSSs aim to integrate relevant BI and analytical models, enabling individuals to approach problems or opportunities from different perspectives with improved information (Sauter, 2014). Arnott and Pervan (2012) position BI within the enterprise reporting and analysis systems (ERASs). Within the specific study context of the banking industry, notable BI tools

such as MS PowerBI, MS Excel, MS SQL, QlikView, Structured Query Language Server Reporting Services (SSRS), Structured Query Language Server Integration Services (SSIS) and MyBI are employed for decision support.

Table 2.1: Seven Types of DSS (adopted from Arnott & Pervan, 2012)

DSS	Definition
Personal decision support systems (PDSSs)	A PDSS is typically a small system designed to support decision-making tasks by one manager or a small group of independent managers.
Group support systems (GSSs)	GSSs comprise software, hardware and language components and procedures that support a group of people participating in decision-making meetings.
Negotiation support systems (NSSs)	NSSs are based on a different theoretical foundation from GSSs and focus on negotiations with opposing parties.
Intelligent decision support systems (IDSSs)	IDSSs involve the application of artificial intelligence techniques to decision support.
Knowledge management based DSS (KMDSS)	KMDSS is a system that supports decision-making by supporting knowledge storage, retrieval, transfer and application.
Data warehousing (DW)	DW provides large-scale data infrastructure to support decisions.
Enterprise reporting and analysis systems (ERASs)	ERASs are enterprise-level systems that include executive information systems (EISs), online analytical processing (OLAP), corporate performance management systems, BI and, more recently, business analytics (BA). BI tools enable the DW to access and analyse information using predefined reporting software, query tools and analysis tools.

In computer science, most DSSs are developed as intelligent systems that support decision-making based on existing databases; the more extensive the database, the greater the accuracy of the system (Ploywattanawong, 2017). Therefore, for DSSs to be successful, decision-making is highly dependent on the availability of integrated, high-quality information

that is organised and presented in a timely and understandable manner (Jooste, 2012). Furthermore, DSSs have changed from a radical innovation that changed the way in which ISs were perceived in business to a mainstream commercial IT movement that all organisations engage with (Arnott & Pervan, 2012; Hosack et al., 2012). DSSs range from sophisticated, customised analytical tools that run on a mainframe computer to spreadsheet-based products running on personal computers (S. Williams & Williams, 2010). DSSs should be easy to use, user-friendly and responsive (Ploywattanawong, 2017).

Table 2.2 displays the established DSS technology goals for assisting decision-makers by Sauter (2014), coupled with a suggested list of DSS characteristics put forth by Asemi et al. (2011) and merged by the researcher.

Table 2.2: DSS Goals (Sauter [2014] **and DSS Characteristics Asemi et al.** [2011]**, Merged by the Researcher)**

No	DSS technology goals	DSS characteristics
1	Look at options to help make decisions and produce better alternatives	DSSs help decision-makers mainly in semi-structured and unstructured situations.
2	Respond to situations quickly	DSSs help to improve the effectiveness and not the efficiency of decision-making.
3	Resolve complex problems	Advanced DSSs are equipped with knowledge that enables the identification of an efficient and effective solution for complicated problems.
4	Brainstorm solutions	
5	Consider more options for solving a problem	DSSs support individuals and groups.
6	Use multiple analyses to solve problems	A DSS can be developed using an integrated approach – this approach entails placing separate functions in separate modules.
7	Have insights into problems and eliminate stereotypes relating to the premature evaluation of options	A DSS can perform “what-if" and goal-seeking analysis.

No	DSS technology goals	DSS characteristics
8	Implement a wide range of decision styles and strategies	A DSS has a graphical orientation – it allows one to create attractive and informative graphical representations that can be used for decision-making.
9	Use data appropriately	A DSS can handle a huge amount of data.
10	Better usage of models	A DSS supports optimisation and a heuristic approach – DSSs can find the optimal solution for minimal problems.

In summary, DSS technology goals encompass assisting decision-makers in various ways, including improving decision quality, facilitating problem-solving, supporting brainstorming and handling data effectively. These goals align with specific characteristics of DSSs, such as their adaptability to different decision scenarios, their ability to handle large datasets and their support for both graphical presentations and analytical approaches.

2.2.2. The Purpose of Business Intelligence Systems and Business Intelligence

Business intelligence systems (BIS) provide the infrastructure for managing and presenting data. Such infrastructure includes hardware platforms, relational database systems and associated software tools which incorporate query and reporting tools that provide access to the data (Loshin, 2012). The BIS relational database systems collect, process and present data concerning customers, competitors, markets, technology, products and the environment (Antoniadis et al., 2015). BIS provide knowledge workers with the tools and methodologies needed to make valuable and timely decisions (Vercellies, 2011). Jerome and Loudcher (2018) state that the purpose of BIS is to automatically aggregate large amounts of structured and unstructured data to provide the following:

- Continuous reporting of the metrics that define the health of a company.
- Assistance for both tactical and strategic decision-making by surfacing descriptive statistics from the data.
- Reporting on anomalies observed in the data.
- The provision of OLAP support to enable quick and customised insights from the aggregated data.

BI grants business access to data to facilitate knowledge and support better management decisions (Moro et al., 2014). BI does so by providing many different areas and technologies that converge to attain the common goal. BI enables businesses to achieve improved business

performance by making use of information assets within critical business processes (S. Williams & Williams, 2010). BI further enables executives to understand the market, the competition and the other forces that could potentially affect their businesses (Kimble & Milolidakis, 2015; Munoz, 2017) by providing DW, BA tools and content/knowledge management (Loshin, 2012).

Figure 2.1 illustrates the purpose of BI within any business context; the business context for the current study is the banking industry. The banking industry has to transform raw data into actionable information by capturing, consolidating, organising, storing, distributing, analysing and providing quick and easy access to information (Ballard et al., 2012). BI enables industries to create knowledge from the information captured for decision-making (Ballard et al., 2012) and to support businesses with actions using critical business processes to achieve improved business performance which involves business information and analysis (S. Williams & Williams, 2010). BI can also be considered a performance management framework that helps companies set their goals, analyse their progress, gain insight, act, and measure their success (Jooste, 2012).

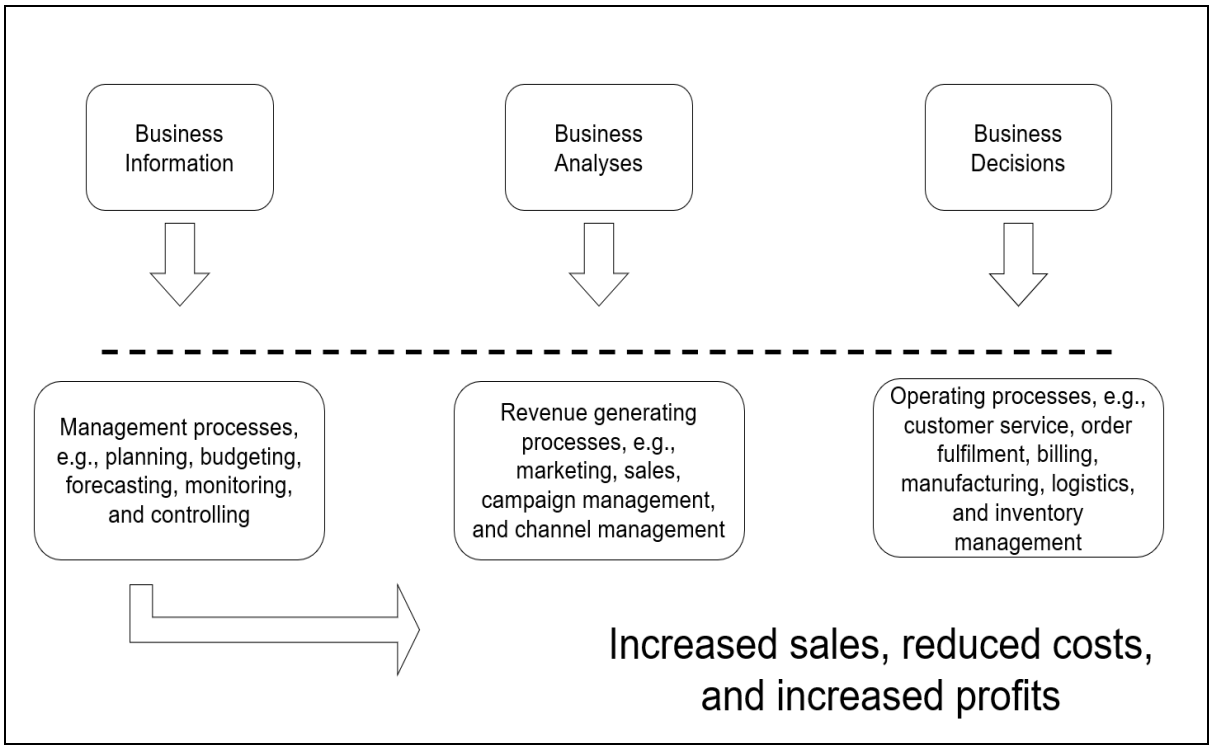

Figure 2.1: The Purpose of BI in Practice (S. Williams & Williams, 2010)

Section 2.3 discusses the BI applications.

2.3. Business Intelligence Applications

BI applications are used to analyse, gather, store and make data easily accessible to help users improve business processes (Audzeyeva & Hudson, 2016; Gul et al., 2014; Yoon et al., 2014). BI applications include the activities of DSSs, queries and reporting, OLAP, statistical analysis, forecasting, data mining and predictive analytics (Brijs, 2012; Wixom & Watson, 2010), EISs, dashboards/scorecards and alerts (Wixom & Watson, 2010). BI applications may vary from model based (e.g. revenue management) to data based (e.g. dashboards) and depend on data infrastructure (Wixom & Watson, 2010). According to Brijs (2012), BI applications can be:

- mission-critical and integral to an enterprise's operations or occasionally designed to meet a special requirement.
- enterprise wide or local to one division, department or project.
- centrally initiated or driven by user demand.

BI applications enable the organisation to address its business priorities and the interrelations between BI and the organisation's structure (Audzeyeva & Hudson, 2016). BI applications have gained substantial attention as a sustainable option for addressing the challenges of complex business decisions (Yoon et al., 2014).

BI applications are widely accepted as middleware between transactional and decision support applications because they can separate business transaction systems from business decision systems (Bahrami et al., 2012; Maaitah, 2023). BI applications comprise several interconnected components that work together to facilitate data-driven decision-making (Pourshahid et al., 2014). Key components of BI include, among others, DW, data sources, data mining, extract, transform and load (ETL) data mining and OLAP (Villar et al., 2018). These components will be further discussed in sections 2.4.1 to 2.4.5, respectively. BI applications enable users to interact with data and glean insights using various methods such as algorithms, predictive analysis and descriptive analysis (Ghazanfari et al., 2011).

Section 2.4 presents the components of BI.

2.4. Business Intelligence Components

Figure 2.2 depicts several components of BI. These components of BI are key concepts and technologies that are closely related to the process of transforming data into actionable insights. Figure 2.2 further shows the facilitation of the transition from raw data to informed

decisions by providing tools and processes for collecting, processing, analysing and presenting data and information. Processes are a very important part of BI; for example, there must be processes for extracting, transforming and loading data, and maintaining metadata (Wixom & Watson, 2010). BI components include DW, data sources, data mining, ETL and OLAP, which will be discussed in sections 2.4.1 to 2.4.5, respectively.

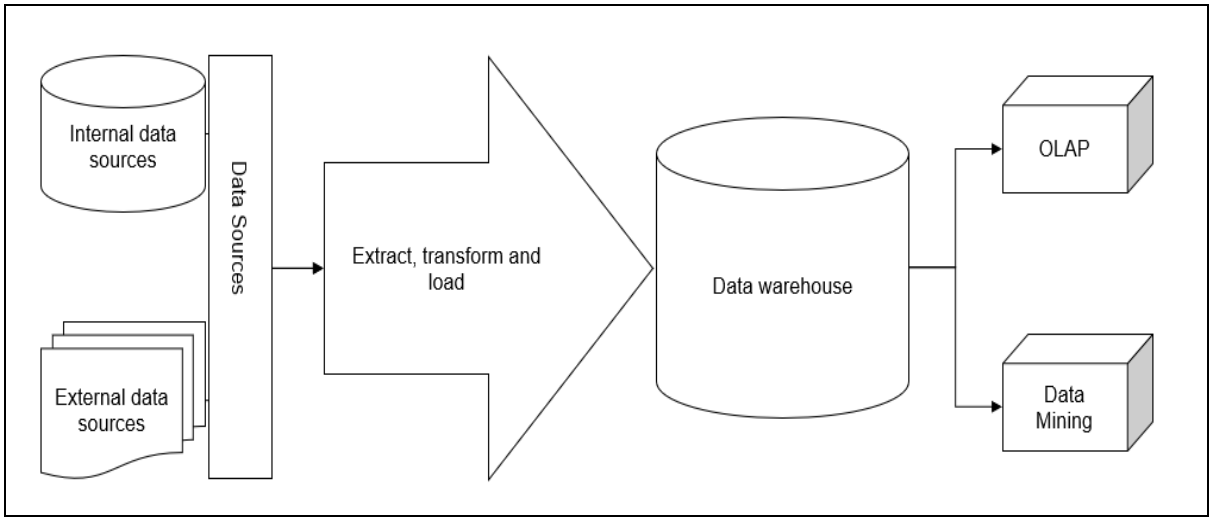

Figure 2.2: BI Components and the Facilitation thereof (Created by Author)

2.4.1. Data Sources

Moscoso-Zea et al. (2018) state that data sources comprise data analysis of the information supply analysis pertaining to the organisation. This information supply analysis includes a study of all relevant data sources that will be significant within the scope of the project. Data sources are the origin of the data used for BI processes. BIS extract, integrate and transform data from these sources into a format suitable for analysis (Hassan et al., 2022). Ensuring the quality and accuracy of the data source is crucial for reliable BI outcomes (Arora & Gupta, 2017).

2.4.2. Extract, Transform and Load

Figure 2.3 shows Mathur's (2016) conceptualisation of the extract, transform and load (ETL) process. This ETL process starts by extracting data from different data sources, then applying any transformation rules required in the transform phase, thereby removing any irrelevant data, and lastly, loading the transformed data into the DW or data marts for consumption by BI applications (Dahr et al., 2022; Olszak, 2016). ETL supports the loading of data to the DW from operational data sources (Moscoso-Zea et al., 2019).

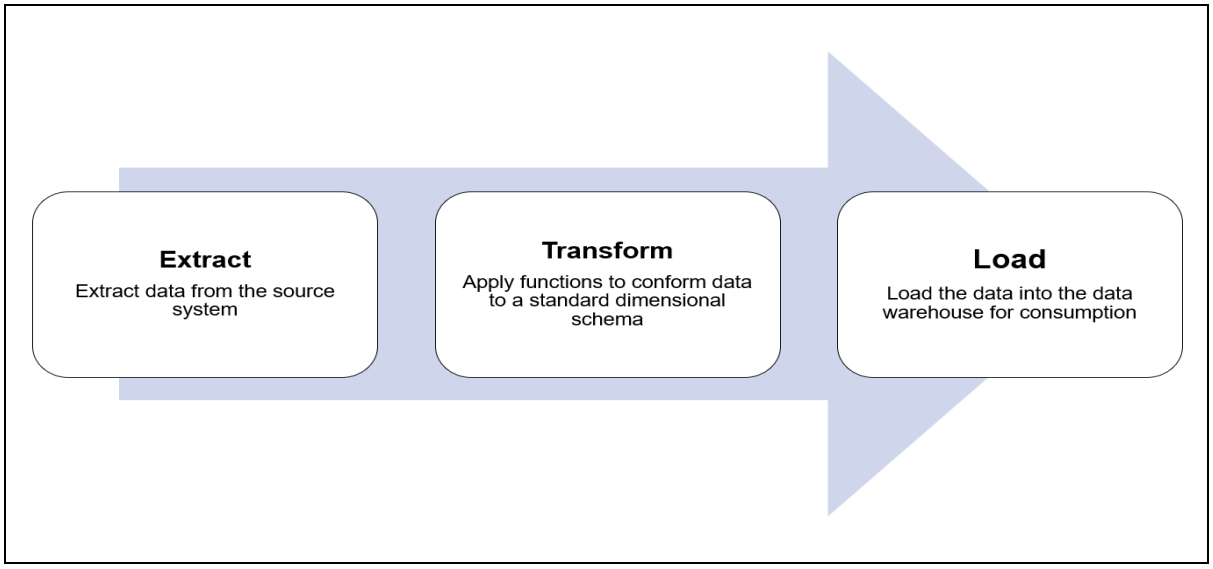

Figure 2.3: ETL Process (Mathur, 2016)

2.4.3. Data Warehouses

Data warehouses (DWs) can store, manage and analyse vast amounts of historic, summarised and non-volatile data (Goede, 2021; Moscoso-Zea et al., 2018). DWs are subject-oriented and integrated, a significant component of BI (Ahmed et al., 2019). DWs support the growth of data (Ahmed et al., 2019) and serve as the foundation of BI systems. DWs consolidate, clean and store data from multiple sources in a structured format, making it accessible and suitable for analysis (Ain et al., 2019; Al-Okaily et al., 2023). DW also support historical data storage, which is essential for trend analysis and reporting in BI (Duque et al., 2022; Hassan et al., 2022).

2.4.4. Online Analytical Processing

Online analytical processing (OLAP) is a multidimensional data modelling technique and a fundamental part of BI reporting and analysis (Ain et al., 2019; Khatibi et al., 2020; Mathur, 2016). OLAP tools feed on the vast amount of data stored in a DW and produce quick answers to business queries that need to consolidate a significant amount of detailed low-level raw data (Maji et al., 2019). Moscoso-Zea et al. (2019) state that these tools support stakeholders in the data analysis and the decision-making process. Moscoso-Zea et al. (2019) further state that these tools help to perform roll-up, drill-down, slicing and dicing operations with the data.

2.4.5. Data Mining

Data mining is a method for mining previously unidentified, concealed and valuable information from the records originating from databanks (Birjandi & Khasteh, 2021; Dhingra, 2018). Data mining techniques can be applied to better understand customer loyalty. Such

data mining techniques include classification, clustering, sequence discovery, association and regression (Sun et al., 2014). Data mining is a component of BI that helps identify valuable insights and predictive models (Bharadiya, 2023) and maybe used to uncover correlations, anomalies and trends in data, providing valuable information for decision-making (Arora & Gupta, 2017). Data mining techniques are often applied to historical data in DWs (Arora & Gupta, 2017).

Section 2.5 presents the BI reporting in the banking context for the purpose of making decisions.

2.5. Business Intelligence Reporting in the Banking Context to Make Decisions

The banking industry is continually looking to get value out of its growing data assets to gain and maintain competitive advantages (Chahal & Bakshi, 2015). In the context of the banking industry, BI facilitates the gathering, processing and transforming of data, turning it into information and then knowledge (Kasemsap, 2016). After gathering BI effectively and proactively, the banking industry can use its power to make informed decisions that contribute to its overall benefit, specifically to improve the timeliness and the quality of information generated. The information is extracted in the form of reports that are customised in line with end-user requirements. These reports are used daily by different business units in the banking industry.

In the application context, Figure 2.4 depicts the data flow initiating from different data sources and progressing through integration processes to enrich data from various source systems. Subsequently, BI tools are used to store the transformed data in the DW. The data in the DW undergoes analysis facilitated by data analysis tools like OLAP, resulting in the generation and presentation of reports to different users.

In the BI environment, data presentation and visualisation take place at the web-enabled business reporting layer in the form of BI reports, dashboards and queries (Dedić & Stanier, 2017). These reports are accessed by different users, including departmental staff, managers and executives through a web-enabled reporting layer, using tools such as MyBI. The web-enabled reporting layer can host different reports that are built using various reporting tools such as MS PowerBI, QlikView and SSRS.

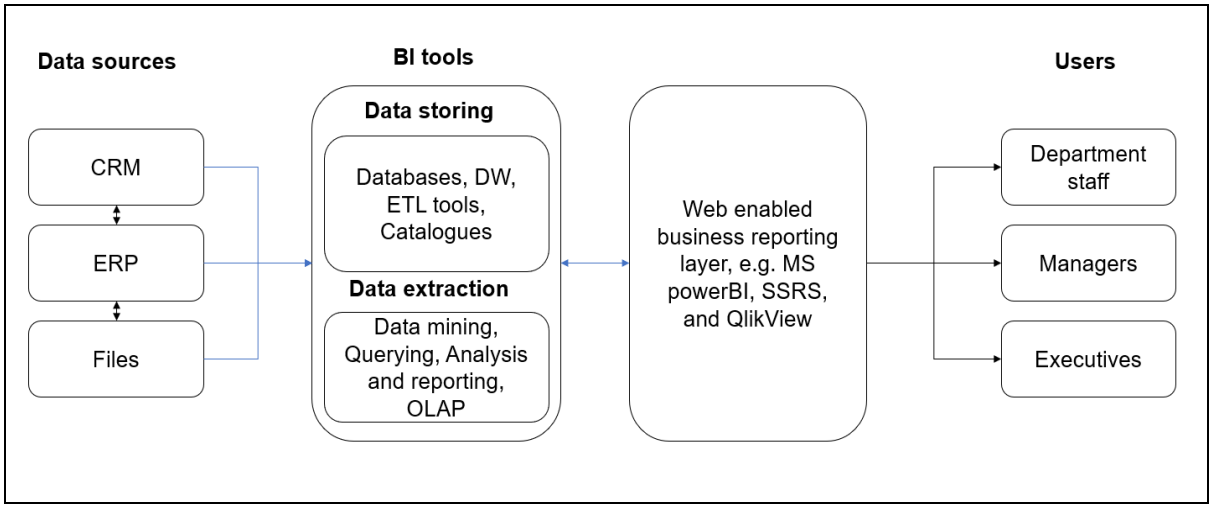

Figure 2.4: BI Reporting Layer (Created by Author)

The reporting layer provides users with meaningful data and is a core concept in BI (Anadiotis, 2013; Dedić & Stanier, 2017). BI reporting involves the use of a data analytics software solution by an individual or organisation to collect, prepare and present data so that it is readily accessible for consumption, accurate for analysis and reliable to inform future business decisions (Gartner, 2022; Tableau, 2023). BI reporting serves as a method for offering information or reporting to client users or companies using BI software (Srivastava et al., 2022). Recognised as fundamental to every business, BI reporting plays an important role in providing a more visual-based, interactive interface to facilitate decision-making processes (Gartner, 2022; Quamar et al., 2020).

Section 2.6 presents a summary of the chapter summary.

2.6. Summary

BI is a dynamic and rapidly developing field of great importance to the banking industry. This chapter summarised the BI components fundamental to investigating BI usability in the banking context.

The key BI components examined in this chapter, namely DW, data mining, ETL and OLAP, work synergistically to gather, process and analyse data for BI applications, especially in the banking sector, as well as leveraging tools such as MS PowerBI, QlikView and SSRS for informed decision-making. Furthermore, it was shown that BI reporting in the banking sector involves using data analytics software such as algorithms and predictive and descriptive analysis to collect, prepare and present the information visually, providing an interactive interface for exploring the numbers and identifying trends.

As noted, there are challenges to BI adoption, some of which relate to the usability of BI systems. While some studies focus on the evaluation of BI, none conducted in the banking industry have included the usability of BI as a component of their study. Using a narrative literature review (NLR) and a systematic literature review (SLR), Chapter 3 explores human–computer interaction (HCI), usability concepts and criteria and user experience (UX), which are later used to identify usability criteria for BI in the banking industry.

CHAPTER 3 : A NARRATIVE AND A SYSTEMATIC LITERATURE REVIEW OF USABILITY AND ITS CONCEPTS

3.1. Introduction

Using a narrative literature review (NLR), Chapter 2 presented an overview of decision support systems (DSSs) and business intelligence (BI), covering their purpose, related concepts and components as relevant to this study.

The purpose of this chapter is to provide a contextual understanding of human–computer interaction (HCI), usability, and user experience (UX) relating to BI. Section 3.2 provides an overview of HCI, while section 3.3 provides the definition of usability and its related concepts. The process followed in identifying usability criteria was done in phases. Sections 3.4 and 3.5 describe, respectively, the NLR process in which an initial set of usability criteria were identified, and UX, while section 3.6 describes the relationship between usability and UX. In section 3.7, the systematic literature review (SLR) process that was followed during which the usability criteria for use in BI was identified is discussed. In section 3.8 the literature-based usability criteria (LBUC) identified for the study are presented. Section 3.9 provides a summary of the chapter.

3.2. Overview of Human–Computer Interaction

Human-computer interaction (HCI) encompasses a diverse range of areas, including user interface design, usability assessment and UX research, and is defined as the field of computer science that focuses on the interfaces between humans and computers (Churchill et al., 2016; Dillon, 2019; Harshul et al., 2017; Katona, 2021). HCI is a multidisciplinary field that is inherently dynamic and constantly changes with technology (Churchill et al., 2013). Figure 3.1, as depicted by the Interaction Design Foundation (IxDF), (2016), illustrates the multidisciplinary nature of HCI, highlighting its intersections with various domains and expertise. Initially rooted in computer science, HCI has grown to encompass cognitive science, computer science and human factors engineering (Kozak, 2020).

At its core, HCI is concerned with how humans interact with computers and how computers can provide the user with a good experience (Churchill et al., 2016; Dix, 2002; Harshul et al., 2017). HCI involves designing computer systems and interfaces that prioritise ease of use, accessibility and user satisfaction. HCI is about optimising technology to better align with users' needs and preferences (Kurilovas & Kubilinskiene, 2020).

While computer science as a discipline is concerned with the study and the science of theories and methods that underlie technological systems (Varghese et al., 2012), human factors

engineering focuses on understanding the capabilities and limitations of users interacting with technology. HCI encompasses both of these disciplines in the design, evaluation and implementation of interactive computer systems for human use and the study of major phenomena surrounding them (Hassenzahl et al., 2015; Kocaballi et al., 2018; Ugale, 2018).

Furthermore, HCI explores how the interaction between humans and computing technologies affects activities and productivity (Rajamany, 2023). In essence, HCI plays a pivotal role in shaping the way we engage with and benefit from modern technology, continually striving to make this interaction more user-friendly, efficient and effective.

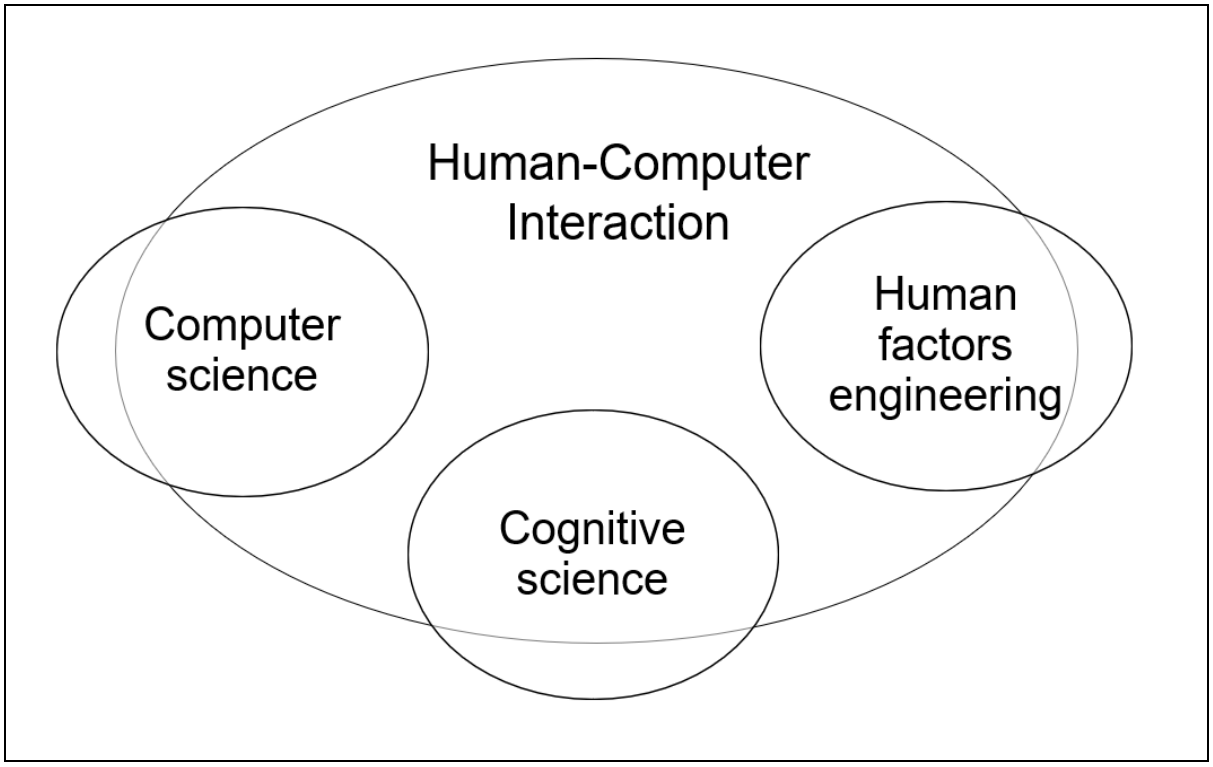

Figure 3.1: Multidisciplinary field of HCI (Interaction Design Foundation - (IxDF), 2016))

The impact of HCI technology is transformative and is changing the world in the way that tasks are performed, as an increasing number of people are using computer systems for their work (Bashir et al., 2014; Harshul et al., 2017). HCI helps to describe the qualities of IT that need to be taken seriously in design and to engage in gaining knowledge (Dillon, 2019; Faisal et al., 2007). Within the domain of HCI, significant research revolves around the interaction between users and products, with a primary focus on two fundamental concepts: usability and UX Hassan & Galal-Edeen, 2018; Rajamany, 2023). Therefore, there is a need to investigate these concepts and explore their similarities and differences, specifically as they pertain to BI. In section 3.3 the usability and its related concepts will be described in more detail.

3.3. Definition of Usability and its Related Concepts

Simply stated, usability is the ability of the user to use the product to carry out a task successfully (Tullis & Albert, 2013). However, usability is not confined to a single, one-dimensional property of the user interface (Nielsen, 1993); rather, usability is a multifaceted concept that encompasses the elegance and clearness of a user interface that has been well-designed (Thowfeek & Salam, 2014). The notion of usability extends to various properties, including learnability, efficiency and correctness (Myers & Stylos, 2016). As articulated by Preece et al. (2002), usability means ensuring that interactive products are easy to learn, effective to use, and enjoyable from the user's perspective. Furthermore, usability has to do with users using the system and expressing how they feel about the system they are using (Hussain et al., 2015). In line with the ISO 9241-11 (2018) definition, usability is the “extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use”. To contextualise this study, the study aligns with the ISO 9241-11 (2018) definition, highlighting the following key points:

- Product – product created by a person, in this case a BI report, consumer product, which is a product used by the system.
- System – composed of a product, service, built environment, or combination thereof, and people.
- Service – means of delivering value for the customer by facilitating the results the customer wants to achieve.

According to Hussain and Kamal (2016), Novak (2014), and Paz and Pow-Sang (2016), usability should be taken into consideration when offering software products to companies since the level of the usability of an interface is a crucial success indicator in a product (McGlinn et al., 2017). As a result, considering the usability measures of any product is essential (Tullis & Albert, 2013). Figure 3.2 shows the usability framework adopted from ISO 9241-11 (2018), which consists of the context of use, product, goals and usability measure. ISO 9241-11 (2018) further emphasises that the usability of a product depends on the context of use. That is, the level of usability achieved will depend on the specific circumstances in which the product is used (Coelho & Nunes, 2012).

The context of use consists of users, tasks, equipment and environment. According to Tullis and Albert (2013), users refer to the people who are supposed to use the product. Tasks refer to the activities needed to achieve a goal and should be related to the goals that need to be achieved. Furthermore, equipment refers to the software and hardware used to support the

user's goal. Finally, environment refers to the user's social and organisational environment based on the attitude towards the introduction of the product.

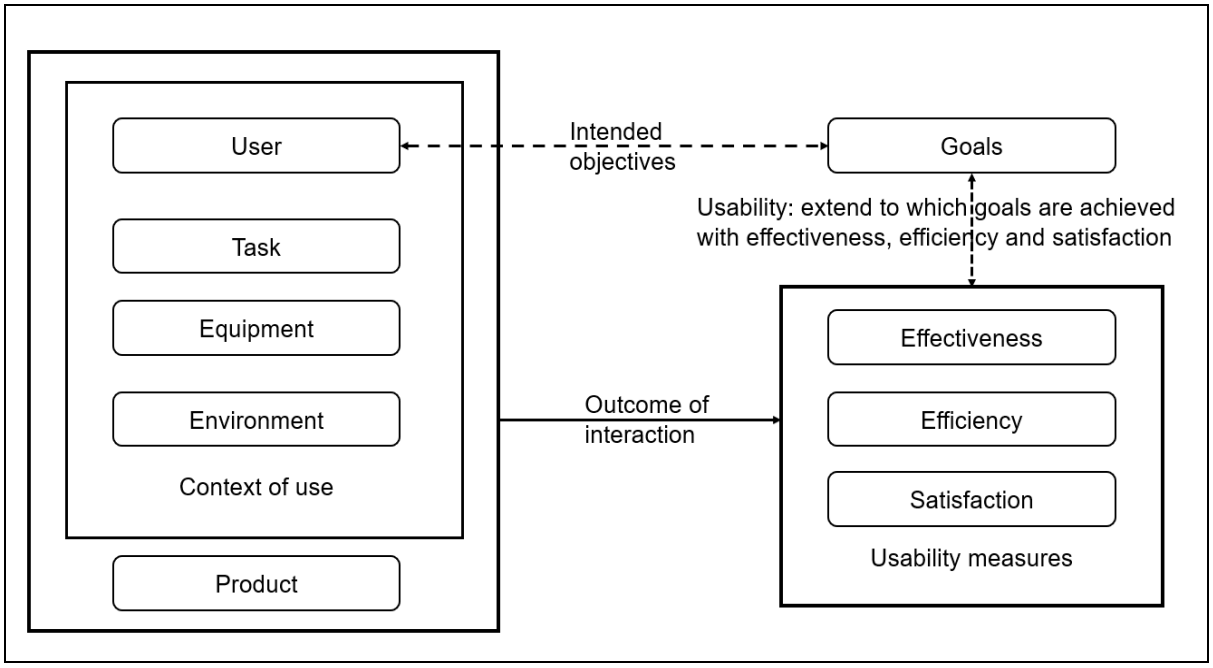

Figure 3.2: Usability Framework (according to ISO 9241-11, 2018)

A product designed with the user in mind is more efficient, easier to learn and more satisfying to use (Nielsen, 1993; Xin et al., 2012). The intended goals or evaluation criteria should be described for the product. Therefore, the measurement of usability requires that we know in advance the characteristics of the target users and the kinds of tasks they will carry out with the system, because a lack of knowledge about either the users or the tasks may lead to the inability to formulate a realistic measurement plan. At least one measure should be provided for each criterion of usability, namely, effectiveness, efficiency and satisfaction (Tullis & Albert, 2013). There is no general rule on the selection of the measures. Usability depends on a specific context of use; and the level of usability achieved will depend on the specific circumstances in which a product is used (Bevan et al., 2015; ISO 9241-11, 2018).

Several usability constructs exist, namely, usability principles, usability goals, usability standards and usability guidelines. These were identified during the NLR on usability and will be discussed in sections 3.3.1 to 3.3.4 respectively. Brosens et al. (2018), Jooste et al. (2013), Smuts et al. (2015) and Dyczkowski et al. (2014) adopted a selection of these constructs and reported on them while focusing on business intelligence systems (BIS). These constructs can be differentiated in terms of scope and abstraction, with principles being the most abstract and standards being the most authoritative. Section 3.3.1 focuses on usability goals, while section

3.3.2 focuses on usability principles and usability design principles. Section 3.3.3 presents usability standards and lastly section 3.3.4 presents usability guidelines.

3.3.1. Usability Goals

Usability goals can be defined as setting up usability criteria for assessing the acceptability of a system and provide guidance at a general level (Rogers et al., 2012). According to Hassan and Galal-Endeen (2018) and Issa et al. (2022), usability goals mean designing a product that is easy, effective and efficient to use, and easy to remember. Scholars suggest numerous usability goals, some of which are prescribed for specific IT systems and services (Mujinga, 2018). The goals are typically operationalised as questions and turned into usability criteria (Rogers et al., 2012). Rogers et al. (2012) identified six usability goals that will make people's interaction with technology effective and enjoyable; these were also adopted in the study by Brosens et al. (2018) (see Table 3.1 below).

Table 3.1: Usability Goals (Brosens et al., 2018; Rogers et al., 2012)

Goals	**Description**	**Reference**
Effective to use (effectiveness)	Effectiveness is a general goal and refers to how good a product is at doing what it is supposed to do (Rogers et al., 2012).	Rogers et al. (2012) and Brosens et al. (2018)
Efficient to use (efficiency)	Efficiency refers to how a product supports users in their tasks (Rogers et al., 2012).	Rogers et al. (2012) and Brosens et al. (2018)
Safe to use (safety)	Safety involves protecting the user from dangerous conditions and undesirable situations (Rogers et al., 2012).	Rogers et al. (2012) and Brosens et al. (2018)
Having good utility (utility)	Refers to the extent to which the system provides the proper functionality so that users can do what they need or want to do (Preece et al., 2002).	Rogers et al. (2012), Brosens et al. (2018) and Preece et al. (2002)
Easy to learn (learnability)	Refers to how easy a system is to learn to use (Preece et al., 2002).	Rogers et al. (2012), Brosens et al. (2018) and Preece et al. (2002)

Goals	Description	Reference
Easy to remember (memorability)	Refers to how easy a system is to remember how to use once learnt (Preece et al., 2002).	Rogers et al. (2012), Brosens et al. (2018) and Preece et al. (2002)

3.3.2. Usability Categories and Usability Principles

According to Rogers et al. (2012), usability principles refer to general guidelines intended to inform the design and evaluation of a system. Usability principles are abstract design rules with high generality and low authority (Dix et al., 2004; Gregor et al., 2020). Therefore, usability principles are more abstract than usability guidelines (Brosens et al., 2018). Dix et al. (2004) divide principles into three categories: learnability, flexibility and robustness. These categories of usability principles, as adopted in the studies by Brosens et al. (2018) and Jooste (2012), can be defined as follows.

- Learnability refers to the ease of use of a new system. Learnability consists of the principles of predictability, synthesisability, familiarity, generalisability and consistency (Brosens et al., 2018; Dix et al., 2004).
- Flexibility refers to the many ways interaction between the user and the system can occur (Brosens et al., 2018). Flexibility consists of dialogue initiative, multi-threading, task migration, substitutivity and customisability principles (Dix et al., 2004).
- Robustness refers to the level of support for successfully achieving and assessing user goals (Brosens et al., 2018; Dix et al., 2004). Robustness consists of observability, recoverability, responsiveness and task conformance principles (Dix et al., 2004).

The usability principles within the three main categories will now be defined in Table 3.2.

Table 3.2: Usability Categories with their Respective Usability Principles (Brosens & Kruger, 2018: Dix et al., 2004; Jooste, 2012)

Category	Principle	Principle Description
Learnability	Predictability	Helps the user to determine the effect of future action based on past interaction history.
	Synthesisability	Assesses the effect of past operations on the current state.
	Familiarity	The extent to which experience in other real-world or digital domains can be applied.

Category	Principle	Principle Description
	Generalisability	Lets users extend knowledge of interaction with applications to similar situations.
	Consistency	Stability behaviour returns results or outcomes arising from similar inputs or tasks.
Flexibility	Dialogue initiative	Users must not be affected by artificial constraints on the input dialogue.
	Multi-threading	Where necessary, the user should be able to attend to more than one task.
	Task migration	Control over task execution should satisfy user preference (i.e. control can switch from the system to the user).
	Substitutivity	Equivalent values for input and output should be allowed.
	Customisability	The user interface of the system is modifiable or adaptable by the user.
Robustness	Observability	Allows the user to evaluate the internal state of the system through its perceivable representation at the interface.
	Recoverability	Allows the user to take corrective action when they recognise an error.
	Responsiveness	Response time should be instantaneous or the system should give some indication that the task is in progress.
	Task conformance	Supports tasks that the user wishes to perform in a way they would understand.

Interaction designers use usability design principles to aid their thinking when designing for the UX (Rogers et al., 2012). These usability design principles can explain a large proportion of the problems one observes in user interface designs (Nielsen, 1993). Usability design principles are derived from a mix of theory-based knowledge, experience and common sense (Rogers et al., 2012). Nielsen's 10 design principles are ubiquitous and valuable because they are the general guideline for interface design (Mazumder & Das, 2014). The Design principles

as formulated by Norman (1990), Rogers et al. (2012) and Nielsen (1993) are summarised in Table 3.3.

Usability principles provide a comprehensive set of high-level guiding principles to improve the usability of interactive systems (Brosens et al., 2018), while usability design principles are prescriptive suggestions to help designers to explain or improve their designs (Rogers et al., 2012). Both design principles and usability heuristics are critical in creating a positive UX, as they ensure that the product is intuitive, efficient and enjoyable to use (GeeksforGeeks, 2023).

Table 3.3: Usability Design Principles (Rogers et al.'s (2012)**, Norman's** (1990) **and Nielsen's** (1993)**)**

Usability Design Principles	**Reference**
a. Visibility – makes the tasks more accessible for users to perform when the functions are visible. b. Feedback – involves sending back information about what action has been done and what has been accomplished, allowing the person to continue with the activity. c. Constraints – restricting the user's actions to avoid errors (Brosens et al., 2018). d. Consistency/mapping – logical relationships between interface elements and their impact on the system (Brosens et al., 2018). e. Affordance – refers to the relationship between the properties of an object and the capabilities of the agent to recognise and sense how the object could be used.	Rogers et al. (2012), Norman (1990) and Brosens et al. (2018)
a. Use of minimal and natural dialogue. b. Speaking the same language as the user. c. Instructions should be clearly visible and retrievable. d. The design should be consistent. e. Ensure that the system provides the user with appropriate feedback. f. Ensure that exits are clearly marked. g. Provide the user with shortcuts. h. Ensure that errors displayed are easily interpreted by the user. i. Ensure that the design can prevent errors. j. Provide users with help, documentation and manuals.	Nielsen (1993)

3.3.3. Usability Standards

Usability standards are developed under the auspices of the International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC) (Jooste, 2012). Many international standards for usability have been formulated in the past (Dawood et al., 2021; Jooste et al., 2014; Rusu et al., 2015) such as ISO 9241-11, ISO/IEC 9126 and ISO/IEC FDIS 9126-1 (Jooste et al., 2013). Probably one of the best-known and widely used definitions is the one proposed by ISO 9241 (Herrera-Valenzuela et al., 2024; ISO 9241-11, 2018; Rusu et al., 2015), which, as stated in section 3.3, states: “the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use’’ (Rusu et al., 2015; Tullis & Albert, 2008). According to Dubey and Rana (2011), usability standards contain usability goals, where in some instances there are overlaps between usability goals and usability standards, for example learnability goals can be found in six usability standards, namely, ISO 9126-1 (2001), Dix et al. (2004), Löwgren (1993), Porteous et al. (1993), IEEE Std. 1061(1992) (1992), and Shackel (1986).

3.3.4. Usability Guidelines

Usability guidelines refer to the proposed compliance measures, which are lower in authority and more general in the application than usability criteria (Jooste, 2012; Tan et al., 2020). Usability guidelines can be formulated on different levels of abstraction according to the target group, for example usability guidelines for managers could be on a higher level than designer guidelines where more detail is required (Renaud & van Biljon, 2017). Usability guidelines are a set of rules that guide designers in developing applications that ensure a high level of usability (Kumar et al., 2019). Such usability guidelines recommend simultaneously considering users, tasks and context to enhance the usability of a system (Ormeño et al., 2013). One example here is Gumussoy (2016), who designed usability guidelines for banking software. His study presented a usability guideline based on heuristics and their corresponding criteria that could be used during the early stages of a banking software design process.

NLR will be employed in section 3.4 to identify NLR-based usability criteria.

3.4. Identifying Narrative Literature Review Based Usability Criteria

Refer to Table 3.1 and Table 3.2 which identify six usability goals and 14 usability principles respectively. Of the six usability goals, two of them, namely efficiency and effectiveness, have similarities to the three usability goals of ISO 9241-11 (2018), namely efficiency and effectiveness and satisfaction (see section 3.3). Therefore, *efficiency* and *effectiveness* will be

included as part of the list of NLR-based usability criteria. *Satisfaction* will also be added to the list because it is an overall metric that is used to measure the satisfaction of users when they interact with the BI reports.

The usability criteria that were selected were based on their suitability in BI banking reports and include *predictability, familiarity, consistency, multi-threading, customisability, recoverability, responsiveness* and *task conformance* (see Table 3.2: Usability Categories with their Respective Usability Principles) as part of the NLR-based usability criteria.

Usability goals are typically presented in the form of specific questions, which are converted to usability evaluation criteria (Lehong, 2020; Preece et al., 2002). Such criteria enable researchers to assess systems, with the aim of identifying usability problems and improving the usability of those systems (Lehong, 2020). The usability goals, usability principles and design principles are operationalised to the same set of usability criteria (Rogers et al., 2012). Therefore, no further distinction between the three will be made and the term usability criteria will be used going forward. Notably, Table 3.4 contains the NLR-based usability criteria. The selection of these criteria was based on their relevance to the study goals, i.e. to investigate and identify the critical usability criteria that should be used to evaluate BI banking reports. Considering the usability criteria in Tables 3.4 and 3.6, learnability, flexibility, robustness, usability design principles and usability goals are on a higher level of abstraction and will thus be referred to as usability categories.

Table 3.4: NLR-based Usability Criteria

No	NLR-Based Usability Criteria	Abstracted Reference
1	Efficiency	ISO 9241-11 (2018) and Rogers et al. (2012)
2	Effectiveness	ISO 9241-11 (2018) and Rogers et al. (2012)
3	Satisfaction	ISO 9241-11 (2018) and Rogers et al. (2012)
4	Predictability	Rogers et al. (2012) and Brosens et al. (2018)
5	Familiarity	Rogers et al. (2012) and Brosens et al. (2018)
6	Consistency	Rogers et al. (2012) and Brosens et al. (2018)
7	Multi-threading	Rogers et al. (2012) and Brosens et al. (2018)

No	NLR-Based Usability Criteria	Abstracted Reference
8	Customisability	Rogers et al. (2012) and Brosens et al. (2018)
9	Recoverability	Rogers et al. (2012) and Brosens et al. (2018)
10	Responsiveness	Rogers et al. (2012) and Brosens et al. (2018)
11	Task conformance	Rogers et al. (2012) and Brosens et al. (2018)
12	Feedback	Rogers et al. (2012), Norman (1990) and Nielsen (1993)

Section 3.5 provides the definition of UX.

3.5. User Experience

User experience (UX) differs from the more objective construct of usability in that UX is concerned with how users experience an interactive product rather than assessing how useful or productive a system is (Rogers et al., 2012). According to Law (2011), UX refers to the quality of the experience a user has while interacting with the specific design of a product, system or service. UX is associated with specific usability evaluation questions which are operationalised to achieve identified UX goals (Law, 2011; Nakamura et al., 2017). Kuniavsky (2003) states that UX is the cornerstone of the success of the product. This resonates with Jesse (2010), who adds that UX is often overlooked during project development and that it will make a huge difference if not overlooked. UX has three defining characteristics, namely, a user is involved, the user is interacting with a product, system or anything with an interface, and the user's experience is of interest and observable or measurable (Tullis & Albert, 2013). Recognising and understanding the trade-offs between usability and UX criteria is essential because it enables designers to become aware of the consequences of pursuing different combinations of these to fulfil the needs of different users (Preece et al., 2002).

Section 3.6 explores the relationship between usability and UX further.

3.6. Relationship Between Usability and User Experience

Usability primarily concerns the effectiveness and efficiency of task completion within a product, focusing on objective metrics like task success rates and time on task (ISO 9241-11, 2018). In contrast, UX encompasses a broader scope, considering the entire user journey, including subjective elements like emotional responses, aesthetics and overall satisfaction (Norman & Nielsen, 1998; Rogers et al., 2012; Sauer et al., 2020).

According to Preece et al. (2002), Marques et al. (2021) and Sauer et al. (2020), UX goals are satisfying, enjoyable, fun, entertaining, helpful, motivating, aesthetically pleasing, supportive of creativity, rewarding and emotionally fulfilling. Mtimkulu (2014) maintains that the relationship between usability and UX is complex. Despite the accepted importance of UX as a concept related to and yet distinct from usability, there still needs to be more clarity on the relationship between UX and usability (Moczarny et al., 2012; Sauer et al., 2020). Figure 3.3 shows different views on the relationship between usability and UX by Moczarny et al. (2012).

Considering Figure 3.3, view 1 shows that UX includes usability, which means that the evaluation of UX requires the extension of existing methods for assessing usability. View 2 shows that usability includes UX. This view (view 2) is held by researchers who believe that satisfaction is the main subjective component of usability and that UX is a broad and rich term for satisfaction (Mtimkulu, 2014). Lastly, view 3 shows that usability and UX are separate but closely related concepts; these may be viewed as intersecting, with similar attributes, but also have specific individual differences (Mtimkulu, 2014).

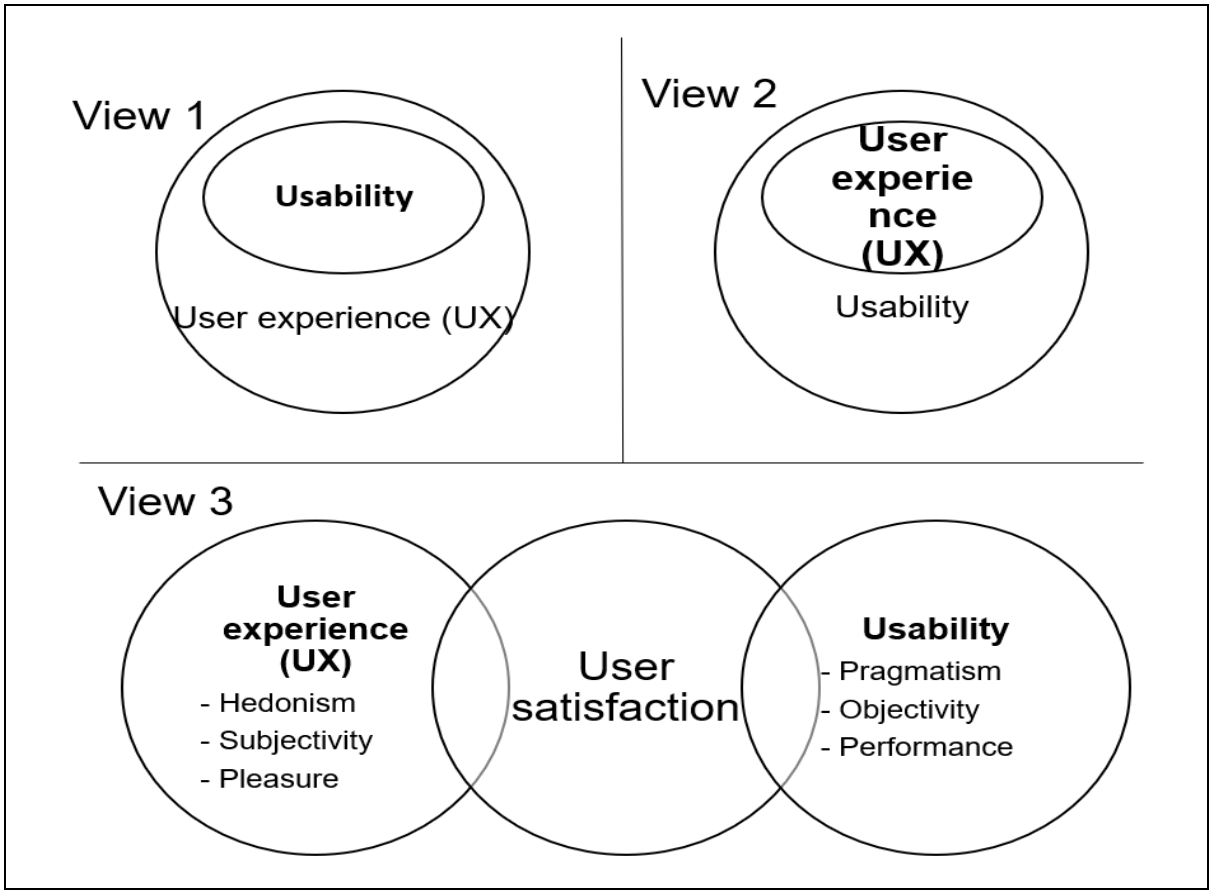

Figure 3.3: Relationships Between Usability and UX (Moczarny et al., 2012)

The current study adopted view 1, which is in line with ISO FDIS 9231-210, which states that UX involves the user's subjective perceptions and responses that result from the use and/or

anticipated use of a product, system or service. According to Jooste (2012), the main difference between UX and usability is that usability features as a product component of UX. As a result, usability and UX goals are vital, such that if system design and development are aligned to them, there is a high possibility of achieving user satisfaction (Lehong, 2020). This also applies to BI reports in the banking industry, which should comply with the requirements of usability and UX in order for the stakeholders to find them usable.

Section 3.7 identifies the usability criteria for BI using an SLR.

3.7. Identifying Usability Criteria for Business Intelligence Using a Systematic Literature Review

Section 3.5 covered the realms of usability and usability criteria and demarcated the distinctions between usability and UX. Section 3.5 established a foundational understanding of HCI, usability and UX, while also illuminating their interrelationships. The NLR-based usability criteria were extracted and presented in Table 3.4. The current section describes the identification of usability criteria for BI by means of a systematic literature review (SLR).

The SLR-based usability criteria identified were compared with the NLR-based usability criteria identified in section 3.4. The overarching objective is to address the RSQ1, namely, what criteria are available to evaluate the usability of BI reports?

The objective of this section is threefold: firstly, the process involved in selecting articles for the SLR will be delineated in section 3.7.1; secondly, the section will delve into the mapping of SLR-based usability criteria for BI which is expanded on in section 3.7.2; and lastly, section 3.7.3 will provide the SLR-based usability criteria identified for BI.

3.7.1. Systematic Literature Review Selection Process

The selection criteria that were used to search for papers encompassed papers published from 2010 to 2019 and selected from the ACM, IEEE and Scopus databases. In a bid to maintain coherence and consistency across the selection process, the initial database query targeted articles containing the search terms 'usability criteria' AND 'business intelligence' AND 'bank' AND 'report'. The initial query, however, yielded no papers, revealing a conspicuous absence of BI usability criteria for banking reports within the selected corpus of knowledge spanning the databases.

The second round of searches was conducted on the same database names, i.e. ACM, IEEE and Scopus database engines, with papers published during the same period, i.e. 2010 to 2019. However, in this instance the selection criteria were refined to focus solely on ‘usability

criteria' AND 'business intelligence'. The modified search yielded a total of five sources from IEEE, two from ACM and nine from Scopus. The combination of these sources resulted in a pool of 16 research papers. Subsequent scrutiny led to the exclusion of one source because the format was not consistent with that of a research paper.

As a result, 15 articles remained for in-depth assessment. The set of 15 articles included three duplicates which were removed. Additionally, three articles were removed from consideration as they did not have the keywords 'usability criteria' in either their title, keywords or full text. Thereafter, nine articles were retained for full analysis for BI usability criteria. The selection process is visually represented in Figure 3.4, providing a clear visualisation of the steps undertaken to refine and select pertinent sources.

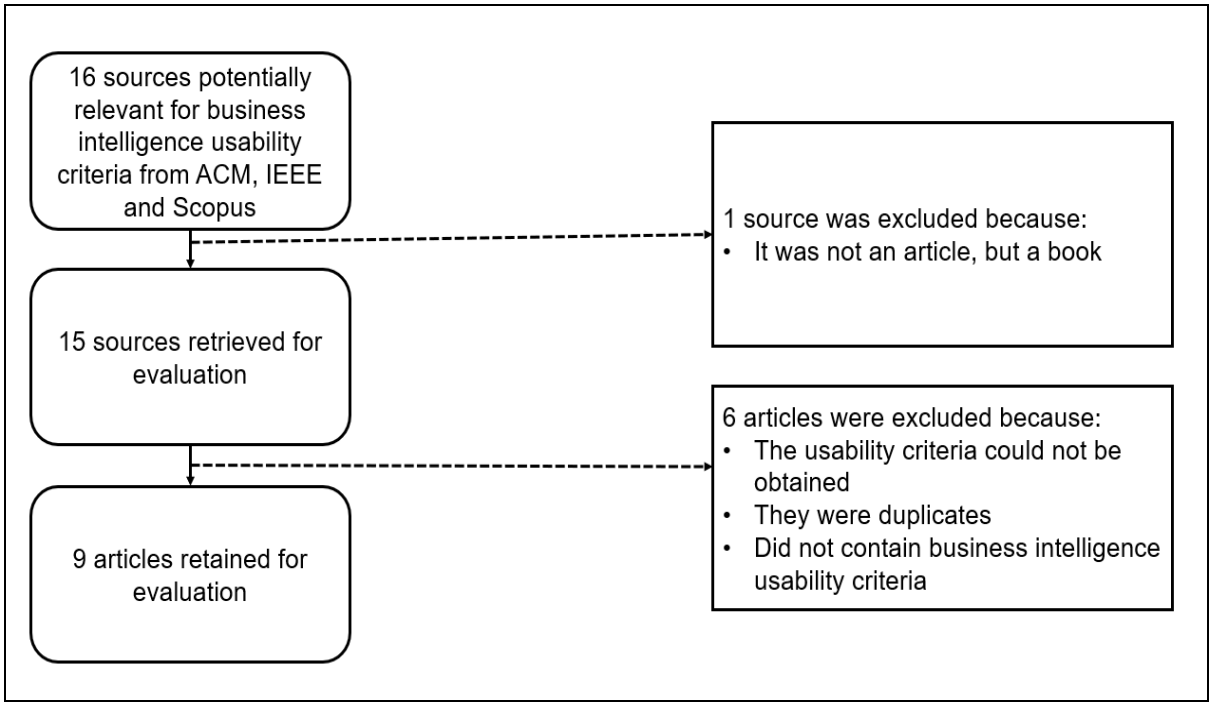

Figure 3.4: Selection Process for BI Usability Criteria (Created by Author)

3.7.2. Mapping of Systematic Literature Review Usability Criteria for Business Intelligence

This section contains the mapping of the usability criteria identified from the IEEE, ACM and Scopus databases, as described in section 3.7.1 (Figure 3.4) using an SLR. The mapping will contain a list of usability criteria as well as a summary of the papers that these criteria were selected from. The insights delivered by the papers analysed are discussed in the following paragraphs.

Eskandari et al. (2017) conducted a study to discuss existing approaches for Bitcoin payments that are suitable for small value transactions by small business. The research design used for their study included developing, implementing prototypes and deploying the open-source system in a real-world café. The contribution of their study involved an evaluation framework utilising security, usability and deployability criteria, as well as an examination of several existing systems and tools.

Hao and Jaafar (2011) conducted a study to understand and evaluate usability practices among practitioners in information and communication technology (ICT) companies in Malaysia. The research design used for their study included a structured questionnaire followed up by semi-structured interviews, either face-to-face or by email.

Chinthakayala et al. (2014) conducted a study to comprehensively compare three social networking sites (Facebook, Twitter and Myspace), providing an in-depth analysis. Their contribution comprises a list of measures for each criterion in order to explore the differences and commonalities between the three social networking sites.

Woskov et al. (2011) conducted a study to identify criteria for improving the relevance of incident notification. The contribution of the study includes the proposed use of case-based reasoning (CBR) for contingency decision support and the identification of key design considerations when implementing a CBR system that is used to deliver relevant notifications following a cyber incident.

Karavite et al. (2018) conducted a study to compare the information foraging application, which they refer to as the ‘Workbench’, and electronic health records (EHR) on four dimensions, namely, effectiveness, efficiency, workload and usability. The research design that was used was a comparative usability test of Workbench and EHR. Their contribution suggests that EHR functionality based on information foraging theory may be beneficial in infection surveillance.

Town and Thabtah (2019) conducted a study to determine which BI tool is more appropriate for data analysis and reporting from an end user's point of view, using an exploratory research design. The contribution of their study comprised an evaluation of Tableau and MS power BI tools in order to assess which is more suitable for students. This was done by applying user interface (navigation), cost, presence in the market, and available training and help as the evaluative criteria.

Smuts et al. (2015) conducted a study to expand on existing BI usability criteria for supporting novice users in their data analysis activities. The study also proposes a set of design guidelines that can be referenced when designing, evaluating and selecting BI tools, and thus

help novice users select the best tool for their needs. Smuts et al.'s (2015) study used a design science research methodology and three research strategies: informal evaluations, research instruments (based on quantitative and qualitative feedback) and participant profiles. The results indicate that the proposed design guidelines can be used effectively to select a BI tool for novices.

Dyczkowski et al. (2014) conducted a study to evaluate the DSSs applied in InKoM (Intelligent Dashboard for Managers) projects, using heuristic evaluation as the research design. Their study analysed commercial and no-commercial BI maturity models using four usability criteria taken from the ISO standard, as well as the usability principles ease of learning, ease of use, flexibility and robustness. Dyczkowski et al. (2014) concluded that the evaluation of DSSs applied in InKoM projects needed improvement, customisable solutions and innovative technologies and concepts.

Jooste et al. (2014) conducted a study to investigate the usability evaluation of BI applications in the context of a coal mining organisation, using user observation, heuristic evaluation and a survey for the research design. Their contribution entails usability evaluation criteria for BI applications, which were presented in the form of guidelines. This study confirms the importance of efficiency, effect, learnability, helpfulness and control as usability criteria in BI applications as used in a coal mining organisation.

The BI usability criteria extracted from the SLR are depicted in Table 3.5: BI Usability Criteria Mapping). This is as per the nine research papers that were retained for evaluation.

Table 3.5: BI Usability Criteria Mapping

No	Usability Criteria	(Chinthakayala et al., 2014)	(Jooste et al., 2014)	(Dyczkowski et al., 2014)	(Woskov et al., 2011)	(Smuts et al., 2015)	(Karavite et al., 2018)	(Town & Thabtah, 2019)	(Hao & Jaafar, 2011)	(Eskandari et al., 2017)
1	Intelligence	X								
2	Efficiency						X			
3	Learnability		X	X		X			X	

No	Usability Criteria	(Chinthakayala et al., 2014)	(Jooste et al., 2014)	(Dyczkowski et al., 2014)	(Woskov et al., 2011)	(Smuts et al., 2015)	(Karavite et al., 2018)	(Town & Thabtah, 2019)	(Hao & Jaafar, 2011)	(Eskandari et al., 2017)
4	Control (Error Control and help)		X			X		X	X	
5	Easy to use			X					X	
6	Robustness			X						
7	Flexibility		X	X		X				
8	Consistency				X					
9	Visibility	X	X			X		X		X
10	Mapping		X			X	X			
11	Task completion									X
12	Time on task						X			
13	Satisfaction						X			
14	Effectiveness						X			
15	Cost							X		
16	Presence in the market							X		X
17	Enjoy of use								X	
18	Recoverability								X	
19	Meet user real needs								X	
20	Fair exchange rate									X

In summary, the papers analysed delivered the following insights that are relevant to this study:

- There is a lack of studies that focus on usability criteria for BI banking reports in the ACM, IEEE and Scopus databases.

- The searches conducted of the ACM, IEEE and Scopus databases showed that there is a lack of BI usability criteria studies, with only 16 studies being returned and only nine yielding results.
- BI usability criteria in other industries exist and may be used for this study, for example the study by Jooste et al. (2014), which was also used by Smuts et al. (2015) in their study.

3.7.3. Usability Criteria Identified for Business Intelligence

Based on section 3.3.2, learnability, flexibility and robustness are referred to as usability categories, while Table 3.5: BI Usability Criteria Mapping shows these as usability criteria identified by the SLR. As a result, learnability, flexibility and robustness are on a higher level of abstraction and will not be added as the SLR-based usability criteria because the respective usability criteria based on the NLR have been included as part of NLR-based usability criteria in Table 3.4. As indicated in Table 3.5, five usability criteria were also identified by the SLR: efficiency, effectiveness, satisfaction, consistency and recoverability. These usability criteria are included as part of the SLR-based usability criteria listed in Table 3.6. Furthermore, visibility and mapping, as identified in Table 3.5, have also been included as SLR-based usability criteria in the same table because they align with the evaluation of BI banking reports.

Table 3.6: SLR-based Usability Criteria

No	Usability Criteria	Abstracted reference
1	Visibility	Chinthakayala et al. (2014), Eskandari et al. (2017), Jooste et al. (2014), Smuts et al. (2015) and Town and Thabtah (2019)
2	Consistency	Woskov et al. (2011)
2	Efficiency	Karavite et al. (2018)
3	Effectiveness	Karavite et al. (2018)
4	Recoverability	Hao and Jaafar (2011)
5	Mapping	Jooste et al. (2014), Karavite et al. (2018) and Smuts et al. (2015)

Section 3.8 presents the literature-based usability criteria (LBUC).

3.8. Literature-Based Usability Criteria for the Study

In total, there are 14 usability criteria (see the LBUC in Table 3.7) that were adopted in this study. Figure 3.5 depicts the progression of the LBUC. The LBUC is made up of the list of the NLR-based usability criteria and the list of the SLR-based usability criteria, as well as the nine usability criteria identified by the NLR, together with four overlaps from the SLR.

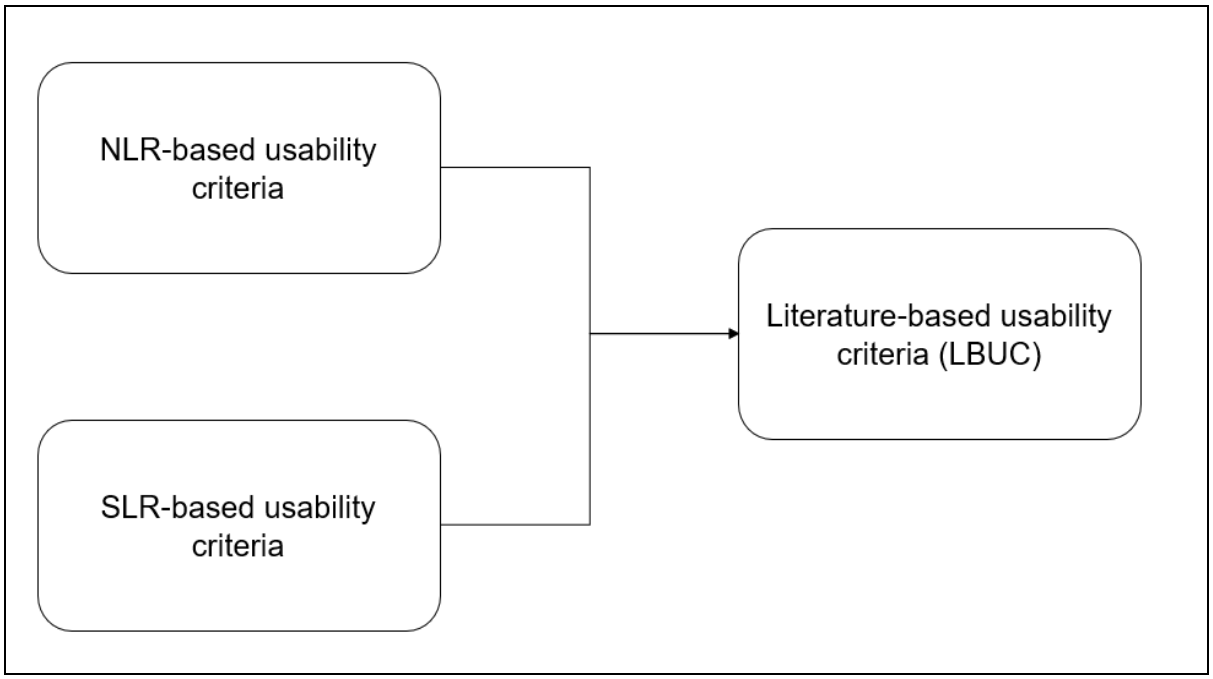

Figure 3.5: Progression of the LBUC (Created by Author)

These LBUC answer the RSQ1: 'What criteria are available to evaluate the usability of BI reports?' These will be refined throughout the study to answer RSQ2, 3, and 4 as well as the main research question. Table 3.7 contains the LBUC that were obtained from both the NLR-based usability criteria and the SLR-based usability criteria.

Table 3.7: Literature-Based Usability Criteria (LBUC)

No	Category	Usability criteria	Usability criteria description	NLR/SLR Indicator	Abstracted reference
1	Learnability	Predictability	The ability to store historic interactions in the BI banking reports based on users' past interactions.	NLR	Rogers et al. (2012) and Brosens et al. (2018)
2	Learnability	Familiarity	The ability of users to interact with the BI banking reports based on their experience in BI.	NLR	Rogers et al. (2012) and Brosens et al. (2018)
3	Learnability	Consistency	The consistency of BI banking reports in terms of their behaviour and results when users interact with the reports.	NLR & SLR	Rogers et al. (2012), Brosens et al. (2018) and Woskov et al. (2011)
4	Flexibility	Multi-threading	The ability to perform more than one task at a time.	NLR	Rogers et al. (2012) and Brosens et al. (2018)
5	Flexibility	Customisability	The ability to allow users to make changes that best suit their needs, i.e. the adaptability of BI banking reports.	NLR	Rogers et al. (2012) and Brosens et al. (2018)
6	Robustness	Recoverability	The ability to recover work after a system failure or allow users to take corrective action.	NLR & SLR	Rogers et al. (2012), Brosens et al. (2018) and Hao and Jaafar (2011)

No	Category	Usability criteria	Usability criteria description	NLR/SLR Indicator	Abstracted reference
7	Robustness	Responsiveness	The ability to indicate the progress of users' actions, e.g. when the user clicks on a report, it should show that the report is loading and how long it takes.	NLR	Rogers et al. (2012) and Brosens et al. (2018)
8	Robustness	Task conformance	The ability to conform to users' expectations.	NLR	Rogers et al. (2012) and Brosens et al. (2018)
9	Usability goals	Effectiveness	The ability to support users and enable them to complete their given tasks effectively.	NLR & SLR	ISO 9241-11 (2018), Rogers et al. (2012) and Karavite et al. (2018)
10	Usability goals	Efficiency	The ability to support users and enable them to complete their given tasks efficiently.	NLR & SLR	ISO 9241-11 (2018), Rogers et al. (2012) and Karavite et al. (2018)
11	Usability goals	Satisfaction	The overall satisfaction of users after using the BI banking reports.	NLR	ISO 9241-11 (2018) and Rogers et al. (2012)
12	Usability design principles	Visibility	The accessibility of the BI banking reports when users need to use them to carry out their duties.	SLR	Chinthakayala et al. (2014), Eskandari et al. (2017), Jooste et al. (2014), Smuts et al.

No	Category	Usability criteria	Usability criteria description	NLR/SLR Indicator	Abstracted reference
					(2015) and Town and Thabtah (2019)
13	Usability design principles	Feedback	The ability to provide feedback to users when carrying out their duties.	NLR	Rogers et al. (2012), Norman (1990) and Nielsen (1993)
14	Usability design principles	Mapping	The ability to allow different reports to interact or users to switch from one report to another.	SLR	Jooste et al. (2014), Karavite et al. (2018) and Smuts et al. (2015)

Section 3.9 gives a summary of Chapter 3.

3.9. Summary

This chapter provided an overview of the field of HCI and the concepts of usability and UX, and explained the relationship between usability and UX. Furthermore, usability goals, usability principles and usability design principles were distinguished. Notably, these were operationalised to the same set of usability criteria despite there being nuanced differences.

The LBUC were identified and listed in Table 3.7. These usability criteria answer RSQ1 and will be used as a basis for answering RSQ2 and RSQ3. The criteria include predictability, familiarity, consistency, multi-threading, customisability, recoverability, responsiveness, task conformance, effectiveness, efficiency, satisfaction, visibility, feedback and mapping.

Chapter 4 focuses on the research methodology, including the research philosophy, research design and research methods.

CHAPTER 4 : RESEARCH DESIGN AND METHODOLOGY

4.1. Introduction

The purpose of this chapter is to explain the research methodology applied in this study, including the research philosophy, design and methods. The chapter describes the philosophical assumptions that underpin the research study, and the research design and methodology used to investigate and identify the critical usability criteria that should be used to evaluate BI banking reports, as well as the chosen research methodology.

The research considered the key components for designing and conducting mixed methods research (MMR), as described by Cameron (2010) and Creswell and Plano (2011). Teddlie and Tashakkori (2010, p. 5) define a mixed methods methodology as: “The broad inquiry logic that guides the selection of specific methods and that is informed by conceptual positions common to mixed methods practitioners (e.g., the rejection of ‘either-or’ choices at all levels of the research process)”. The Five Ps framework of MMR includes paradigms, pragmatism, praxis, proficiency and publishing (Cameron, 2010; Creswell & Plano Clark, 2011; Teddlie & Tashakkori, 2010), which will be further discussed in sections 4.2, 4.4.4, 4.4.5 and 4.4.6, respectively.

This chapter is structured as follows: section 4.2 discusses the philosophical worldview of the research; section 4.3 presents the research design adopted in this study; section 4.4 presents the research method; and section 4.5 concludes the chapter.

4.2. Research Philosophies

A paradigm refers to a system of ideas or worldview (Bunniss & Kelly, 2010; Cameron, 2010; Killam, 2013; Levers, 2013) used by a community of researchers to guide the generation of knowledge (Bunniss & Kelly, 2010; Levers, 2013). A research paradigm is a theoretical or philosophical grounding for the research work, which is also referred to as a research philosophy (Khatri, 2020; Park et al., 2020). Thus, a paradigm defines a researcher’s philosophical orientation and has significant implications for every decision made in the research process, including the nature of reality, the types and sources of knowledge and the choice of methodology and methods (Khatri, 2020).

A *philosophical worldview* is a perception that focuses on a set of beliefs, shared assumptions, concepts, values and practices (Johnson & Christensen, 2010). A *philosophical worldview* guides the subject of the research, the activity of the research and the nature of the research outputs (Pickard, 2013). These include recognising the philosophical theory underpinning the approach and, thus, acknowledging how the research will be conducted (Cronin et al., 2015).

Various philosophical worldviews exist, including constructivism, interpretivism, positivism, post-positivism, pragmatism, critical realism and transformative research (Johnson & Christensen, 2010). For the purposes of this study, a research paradigm and a *philosophical worldview* will be considered to be the same. Going forward, the study will refer to a research paradigm.

As mentioned in section 4.1, the study adopted the five Ps of MMR (namely, paradigms, pragmatism, praxis, proficiency and publishing); the first P of the five Ps of MMR is paradigms. One of the first tasks a researcher needs to undertake is to position themselves paradigmatically (Cameron, 2010). Teddlie and Tashakkori (2010) produced an expansive list of paradigmatic stances within MMR. These stances include a paradigmatic stance, a substantive theory stance, a complementary strengths stance, a dialectic stance and a single paradigm stance, as well as multiple paradigms. The stance adopted for this study is a single paradigm stance. In terms of this stance, the researcher adopts a single paradigm encompassing both qualitative and quantitative research methods (Hall, 2013). Section 4.2.1 contains an overview and definitions of different paradigms, while section 4.2.2 delves into the rationale for choosing pragmatism.

4.2.1. Overview and Definitions of the Research Paradigms

4.2.1.1. Interpretivism

Interpretivism refers to epistemologies or theories about how we can gain knowledge of the world; these loosely rely on interpreting or understanding the meanings humans attach to their actions (Duberley et al., 2012). Goldkuhl (2012) states that the aim of understanding the subjective meanings of persons in studied domains is essential in interpretivism. The core idea of interpretivism is to work with subjective meanings already present in the social world, i.e. to acknowledge their existence, reconstruct and understand them, avoid distorting them and use them as building blocks for theorising.

4.2.1.2. Positivism

Positivism is a position in the philosophy of science that emphasises the importance of observation for the growth of knowledge and thus considers the measurement of phenomena as central to the development of understanding (Fox, 2012). A key aspect of positivism is the tendency to reduce human behaviour to the status of automatic responses excited by external stimuli wherein the subjective dimension to that behaviour is lost, intentionally or otherwise (Duberley et al., 2012). The assumptions about truth and reality and ways of knowing about

this reality that inform these criteria are primarily associated with positivism (D'Cruz & Jones, 2014).

4.2.1.3. Pragmatism

Pragmatism concerns action, change and the interplay between knowledge and action (Goldkuhl, 2012). It is a method for attaining clarity of ideas within a normative conception of logic, as well as within the norms for continuing, self-correcting (Baran & Jones, 2016; Goldkuhl, 2012). According to McCaslin (2012), Creswell (2014) and Morgan (2014), pragmatism is concerned with what works and solutions to problems and that truth is relative to the current situation. Pragmatism strongly emphasises research questions, communication and shared meaning-making (Morgan, 2014; Shannon-Baker, 2015). From a pragmatic point of view, research is a form of action to meet the goals framed in research questions (Morgan, 2014).

4.2.1.4. Postpositivism

Postpositivism is established by the research design, statistical hypotheses and possible findings (Baran & Jones, 2016). In postpositivism, the scientific method accepts the approach that entails an individual beginning with a theory, then collecting the data that supports the theory or making necessary changes to test the theory (Baran & Jones, 2016).

4.2.1.5. Constructivism

Constructivism bridges the gap between positivism and postpositivism (Baran & Jones, 2016). Constructivism refers to an individualistic position, emphasising the unique experience of individuals (Newton & Burgess, 2016). It ascertains that multiple truths exist, which are determined by individuals' unique perspectives and experiences (Baran & Jones, 2016).

4.2.2. Why Pragmatism?

As a research paradigm, pragmatism accepts that single or multiple realities are open to empirical inquiry (Creswell & Plano Clark, 2011; Frega, 2011). The focal concern of pragmatism is the outcomes, i.e. how things eventuate in practice (Rescher, 2016).

This study gathered quantitative and qualitative data from participants who used the BI banking reports for their operational and strategic work. As a result, the most appropriate paradigm for this study was deemed to be that of pragmatism.

According to the MMR framework, pragmatism is the second P of the five Ps of MMR. In its simplest sense, pragmatism is a practical approach to a problem and has strong associations

with MMR (Cameron, 2010). This embodies the discussion of pragmatism as a bridge between philosophy and methodology and brings us to the third of the Five Ps, praxis (Cameron, 2010). The following section presents the research design applied in this study.

4.3. Research Design

The research design refers to formal and informal approaches to structuring the way the research takes place (Miller, 2016), and research issues and questions are addressed by means of a research design framework (Ang, 2014). Research design also involves a degree of reflexivity on the part of the researcher, who should acknowledge the underlying theory or theoretical assumptions that have shaped their perspectives and understandings of the research focus and process (Cheek, 2012).

The research design employed in this study is empirical (see Figure 4.1). In an empirical study, the researcher determines the data needed to investigate the research questions and specifies the sampling criteria and research instruments accordingly (Jaakkola, 2020). Empirical research is based on credibility, confirmability and other core tenets of rigour, all of which are interconnected and linked to the researcher's objective or subjective stance (Bhattacharya, 2012). In essence, empirical research describes, explains and predicts the world (Johannesson & Perjons, 2021) and is typically about producing generalisable knowledge, making claims with support (or at least applicability), beyond a specific time and space. Empirical research questions deal with the world 'as it is', seeking general explanations for patterns of outcomes or classes of phenomena (Powner, 2015). Figure 4.1 presents the research design for the current study, i.e. the overall flow of information. This figure is adapted from Pilkington and Pretorius's (2015) study and depicts the philosophical worldview, research design and research methods employed in this study.

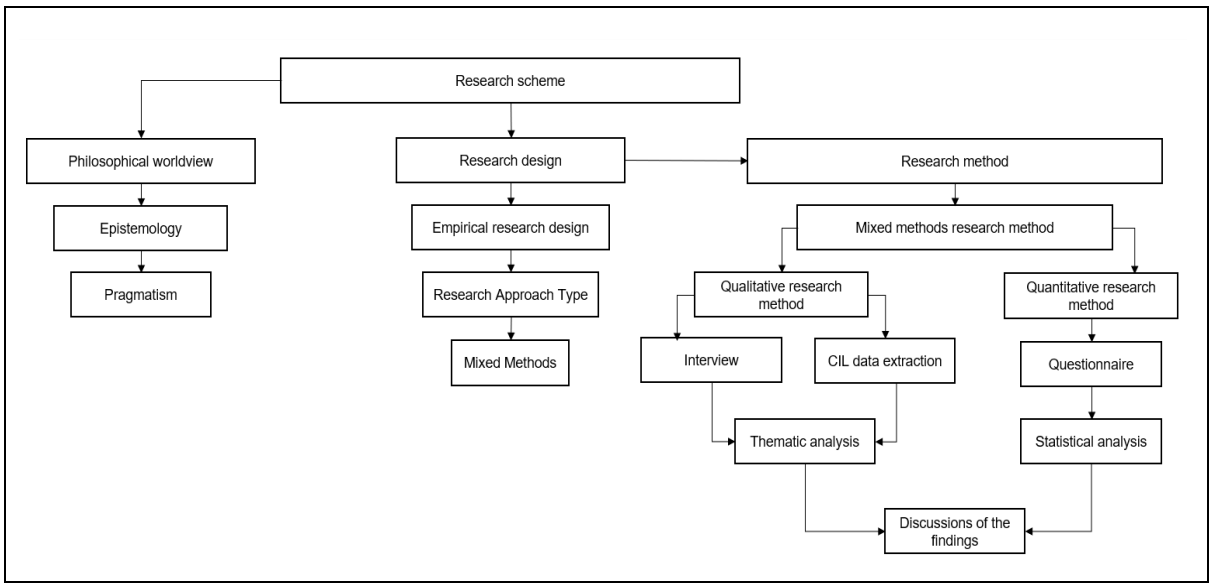

Figure 4.1: Research Methodology (extracted from a paper by Pilkington & Pretorius, 2015)

The research design chosen for this study was mixed methods, with pragmatism as a research philosophy. Research methods involved various tools used for research inquiries, such as data collection and analysis and the interpretation of the findings (Creswell, 2014; Walliman, 2022). Specifically, the researcher used survey, company issues log (CIL) data extraction and interviews as research methods. In this study, the survey captured quantitative data, whereas qualitative data was captured from the CIL data extraction and interviews. In this type of study, both quantitative data and qualitative data are required, MMR is appropriate. The advantage of the MMR is that the results of the different data capturing strategies can be triangulated and compared to validate the findings.

Section 4.4 discusses the research method for the study.

4.4. Research Method

This study employed MMR to investigate and identify the critical usability criteria that should be used to evaluate BI banking reports. The case for MMR has generally been stated in terms of its propensity to enable researchers to combine breadth and depth in empirical inquiries, enhance the validity of research findings through triangulation and facilitate the mobilisation of multiple theories in examining accounting practices (Fraser, 2014).

MMR as a distinct subfield has specific principles that govern the production of knowledge and the rewards of governance (Timans et al., 2019). For this study, the proposed list of critical usability criteria for the BI banking reports is the targeted artifact that needs to be usable. It should ensure that users are satisfied using their reports.

MMR has witnessed a rapid rise in popularity in the last ten years (Cameron, 2010). As mentioned in section 1.5, MMR is an approach to inquiry involving collecting both quantitative and qualitative data, integrating the two forms of data and using distinct designs that may involve philosophical assumptions and theoretical frameworks (Creswell, 2014).

The following sections present the data collection techniques in section 4.4.1 and data capturing in section 4.4.2. Section 4.4.3 discusses data triangulation and section 4.4.4 the statistical data analysis for the survey. Section 4.4.5 discusses the thematic data analysis for CIL data extraction and interviews, while section 4.4.6 presents the validity and reliability. Section 4.4.7 presents praxis, the third P of the MMR framework, and section 4.4.8 presents proficiency, the fourth P of the MMR framework. Lastly, section 4.4.9 presents publishing, the fifth P of the MMR framework.

4.4.1. Data Collection Techniques

Data was collected using a survey, CIL data extraction and interviews. Each of these data capturing techniques are now discussed in more detail.

a) Survey

Surveys consist of (relatively) systematic, (mostly) standardised approaches to collecting information on individuals, households, organisations, or larger organised entities by questioning systematically identified samples (Czaja et al., 2014; Marsden & Wright, 2010). Surveys can be conducted in person, by phone, by mail, or over the internet, among other methods (Czaja et al., 2014). For this study, the survey was conducted over the internet owing to the Covid-19 restrictions and the aftermath.

This survey consisted of Sections A and B. Section A comprised questions relating to the participants' demographic information. Some of the critical demographic variables included ethnicity, age, gender, education level and job experience. Section B contained questions relevant to the LBUC of this study and took the form of closed-ended questions. The participants rated each question using a five-point Likert scale, i.e. an ordinal scale ranging from 'strongly disagree' to 'strongly agree' (Brooke, 2013). The measurement items (LBUC) used in the survey were developed from the NLR and SLR explorations.

The survey data was gathered using Google Forms and MS forms. The survey data collection form was initially created using Google Forms; however, after sending it to the participants for feedback, some replied saying that they were getting an error. This might have been that Google Forms was restricted from their laptops. As a result, the same form was duplicated for completion in MS Teams. The second email advised the participants that if they had already completed the Google form, they did not have to complete the MS form survey as the two were identical (see Appendix C).

b) Company Issues Log Data Extraction

The bank at which this study was conducted has a team that develops and maintains the BI banking reports to ensure that the reports are updated and to resolve issues as they arise. This team uses a portal, referred to as the company issue log (CIL), to capture issues relating to the BI banking reports. The researcher consequently extracted data from the CIL to analyse whether there are any BI banking report issues relating to usability that users were experiencing. The CIL data extraction and data analysis was performed after the survey. This data was extracted to an MS Excel spreadsheet and then transferred to a MS Word document and classified according to the types of request users selected when logging requests on the

CIL. Subsequently, the researcher uploaded these documents to the *Atlas.*ti tool for thematic analysis (TA).

c) Interviews

A commonly used method of data collection is qualitative research interviews (Atkinson, 2012; Jamshed, 2014; Janghorban et al., 2014). The most basic definition of an interview is a purposeful conversation between two people (an interviewer and an interviewee) to obtain information concerning a pre-identified intention (Martin, 2010; Persaud, 2010). The person asking the questions is the interviewer, whereas the person providing the answers is the interviewee (i.e. participant) (Persaud, 2010). Various forms of interview exist structured, semi-structured, open, life history, collaborative and computer-mediated interviews, as well as focus groups (Atkinson, 2012). The category best suited to this study was deemed to be semi-structured, online interviews.

Various ways of recording what is said and done during an interview exist such as taking handwritten notes or audio recording. If the researcher is audio recording data, they must transcribe recordings verbatim prior to data analysis (Platt, 2012; Sutton & Austin, 2015).

Interviews were held to obtain the participants' feedback on usability issues related to BI banking reports. The responses were recorded and the recordings transcribed (a feature of MS Teams). Additionally, the researcher re-listened to the recording and transcribed it using MS Word. The interview comprised three sections: Section A was intended to capture the demographic information and included a binary question regarding the participants' satisfaction with the BI banking reports; Section B contained the questions to be asked in the semi-structured interviews regarding the BI banking issues identified from the findings of the CIL data extraction and the survey based on the LBUC synthesised in Chapter 3 (Table 3.7); and Section C of the interview used a Likert-type scale, rating answers from 1 to 5 in order to ascertain whether the participants were satisfied with the BI banking reports. The interview data was captured using MS Word (see Appendix D).

Section 4.4.2 discusses data capturing.

4.4.2. Data Capturing

In answering research questions, it is doubtful that researchers would be able to collect data from all cases (Shorten & Moorley, 2014; Taherdoost, 2016). Hence, there is a need to select a sample (Berndt, 2020; Taherdoost, 2016). The sampling method chosen should be as rigorous as possible to ensure minimum error and bias and to enhance maximum representativeness (Tyrer & Heyman, 2016). Sampling methods are categorised into

probability or non-probability methods (Omair, 2014; Tyrer & Heyman, 2016). Probability sampling methods incorporate an aspect of random selection, which ensures that each case in the population has an equal likelihood of being selected (Shorten & Moorley, 2014; Tyrer & Heyman, 2016). Non-probability sampling methods use an approach in which the sample is selected based on the subjective judgement of the researcher instead of using random selection (Elfil & Negida, 2017; Tyrer & Heyman, 2016). For the purposes of this study a non-probability sampling method was selected.

Common types of non-probability sampling methods include quota sampling, snowball sampling (Berndt, 2020; Tyrer & Heyman, 2016), convenience sampling and judgement sampling (Elfil & Negida, 2017). For this study convenience sampling was chosen.

Convenience sampling involves selecting participants on the basis that they are readily and easily available (Elfil & Negida, 2017; Taherdoost, 2016; Tyrer & Heyman, 2016) and affordable (Suen et al., 2014).

The participants for this study consisted of specialists, analysts and managers working in one SA bank. The application of the data capturing methods is discussed below:

a) Survey

Participants were contacted by email via a central email address. The email contained the survey link and was sent in the hopes that everyone would respond. The central email address consisted of 274 participants, of which only 98 responded by completing the survey.

b) Company Issues Log Data Extraction

The CIL data extraction comprised extracting data from the organisation's portal. As mentioned in Chapter 1 (section 1.2), CIL is a portal that is used by stakeholders to log requests relating to BI reports, report portals and database issues experienced by stakeholders while doing their work at the bank. The data was captured in an MS Word document. Data retrieval took place from June 2020 to March 2021.

c) Interviews

Owing to the Covid-19 regulations, the interviews were conducted via the online discussion forum accepted by the bank and the University of South Africa (Unisa), and MS Teams was used to conduct the interviews. Prior to conducting the interviews, the researcher randomly selected interviewees using the central email address while also ensuring that interviewees were not known personally. Once a random list was made, the researcher emailed the participant consent form and the information sheet. The consent form was signed

electronically and emailed back to the researcher so that the researcher could schedule the interview. Thirty-one participants were interviewed.

Section 4.4.3 discusses data triangulation.

4.4.3. Data Triangulation

Fielding (2012) states that data integration is crucial in mixed methods analysis and conceptualisation. The three purposes of data integration are illustration, convergent validation (triangulation) and the development of analytic density (Fielding, 2012). For the current study, we used convergent validation, called triangulation. Triangulation uses multiple methods to develop an in-depth understanding of the phenomenon (Bentahar & Cameron, 2015; Creswell & Plano Clark, 2011; Denzin, 2012; Heesen et al., 2019). Triangulation allows scholars to document consistent findings using different means for obtaining those findings, increasing the confidence that the findings are not driven by a particular method or data source (Gibson, 2017).

Triangulation, as a strategy, is used to test credibility and validity through the convergence of information from different sources or data collection methods (Carter et al., 2014; Koc & Boz, 2014; Tillyer et al., 2010). Triangulation as a multi-strategy research method may be used to achieve five primary objectives: 1) to enhance the credibility of research findings, 2) to enable cross-validation complementarity, which allows the researcher to gain a fuller understanding of the research problem, 3) to more easily identify paradoxes and contradictions , thus allowing a review of the research design and objectives, 4) to allow the researcher to see the shortcomings and advantages of methods more clearly for future use, and 5) to expand the breadth and range of research by using different methods for different inquiry components (Koc & Boz, 2014).

Triangulation is used to verify findings and thus improve rigour (Lehong, 2020). In this study, triangulation was used to compare the findings obtained from analysing the survey data, the CIL data extraction and the interview data. The results of the analyses of all techniques were documented and discussed in this study (see section 6.5).

Two data analysis methods were used for this study, namely, statistical analysis and TA. Section 4.4.4 briefly describes the statistical analysis of the survey results, while section 4.4.5 briefly describes the TA of the CIL data extraction and the interviews.

4.4.4. Data Analysis: Statistical Analysis of Survey Results

Statistics is the field of study, the objective of which is to transform data into information (Heiberger & Holland, 2013; York, 2020), which helps us make decisions (York, 2020). Statistical analysis was used to analyse the data collected using the survey. Different types of statistical analysis exist; for the purpose of this study, descriptive statistical analysis was used. Descriptive statistics summarise a set of observations to communicate as much information as possible as simply as possible (Mishra et al., 2019). Descriptive statistics are reported numerically in the manuscript in its tables or graphically in its figures (Vetter, 2017). The descriptive analysis for this study was reported in a table, which contains the number of participants, as well as the minimum, maximum, mean and standard deviation. In this regard, graphs and tables were created using the Statistical Package for the Social Sciences (SPSS). The SPSS and MS Word and Excel provided the graphs and charts used to analyse quantitative data.

4.4.5. Data Analysis: Thematic Analysis of Company Issues Log Data Extraction and Interviews

Thematic analysis (TA) was used to analyse the data collected from the CIL data extraction and the interviews. TA is a qualitative research method for describing data and involves interpretation by means of selecting codes and constructing themes (Braun & Clarke, 2006, 2021; Kiger & Varpio, 2020). TA approaches typically acknowledge the potential for inductive (data-driven) and deductive (theory-driven) orientations to coding, capturing semantic (explicit or overt) and latent (implicit, underlying, not necessarily unconscious) meanings, processes of coding and theme development, and the potential for some flexibility around the theory that frames the research (Braun & Clarke, 2021; Kiger & Varpio, 2020). The TA captured participants' responses using codes (Crowe et al., 2015).

TA codes the data based on the main categories identified in the participants' feedback in order to gain a more structured set of criteria (Mirkovic et al., 2014). This study followed TA rules and requirements to code the attributes from the participants' feedback, as advocated by Braun and Clarke (2006). TA involves the use of six phases of analysis, as depicted in Table 4.1 (Braun & Clarke, 2006).

Table 4.1: Doing Thematic Analysis Step-by-step Guide (Braun & Clarke, 2006)

No	Phases	Phase details
1	Phase 1: familiarising yourself with your data	When data has been collected, you need to immerse yourself in it to the extent that you become familiar with the depth and breadth of the content (Braun & Clarke, 2006); Therefore, it is advisable to read through the entire data set at least once before you begin your coding, as your ideas and the identification of possible patterns will be shaped as you read through it. In this study, this phase was applied as follows: a) CIL data extraction – the researcher went through the CIL data to become familiar with the data extracted from the organisation's portal. b) Interview – the research went through the interview recordings and transcriptions to become familiar with the data collected during the interviews.
2	Phase 2: generating initial codes	This phase involves the production of initial codes from the data after having read and familiarised oneself with the data (Braun & Clarke, 2006). This study applied a manual coding process. This involved reviewing the data line items and creating codes using specific words or text strings from the documents. a) CIL data extraction – the researcher reviewed the data extracted from the CIL using *Atlas.ti* and created codes from the data based on the different documents uploaded. b) Interview – the researcher reviewed the data collected from the interviews and generated initial codes.

No	Phases	Phase details
3	Phase 3: searching for themes	This phase, which re-focuses the analysis on the broader level of themes rather than codes, involves sorting the different codes into potential themes and collating all the relevant coded data extracts in the identified themes (Braun & Clarke, 2006). A theme is a coherent and meaningful pattern in the data relevant to the research question(Clarke & Braun, 2013). Themes can be described as the subjective meaning and cultural-contextual message of the data(Vaismoradi & Snelgrove, 2019). In other words, a theme is a thread of underlying patterns of shared meaning underpinned by a central organising concept (Braun & Clarke, 2019; Erlingsson & Brysiewicz, 2013). Theme building is a mental step that consists in identifying similar codes and grouping them into themes (Shoufan, 2023). a) CIL data extraction – the themes created for the CIL data was based on the request types. This is discussed further in Chapter 5 (section 5.3). b) Interview – the themes created from the interview data were in line with the BI report issues identified from the CIL data. A discussion in this regard may be found in Chapter 6. A deductive approach was used to generate themes in Atlas.ti for both the CIL data extraction and the interview data.
4	Phase 4: reviewing themes	Reviewing themes involves a process of checking whether the themes work in relation to the coded extracts and the entire data set (Clarke & Braun, 2013; Scharp & Sanders, 2019; Vaismoradi et al., 2013). The researcher should reflect on whether the themes tell a convincing and compelling story about the data and begin to define the nature of each individual theme and the relationship between the themes (Clarke & Braun, 2013). During this phase, it will become

No	Phases	Phase details
		evident that some candidate themes initially considered are not themes (e.g. if there needs to be more data to support them or the data are too diverse). In contrast, others might collapse into each other (e.g. two separate themes might form one theme) (Braun & Clarke, 2006). a) CIL data extraction – to finalise the themes, the researcher re-evaluated the decision to create themes based on the request types. b) Interviews – to finalise the themes, the researcher re-evaluated the decision to create themes based on the BI report issues.
5	Phase 5: defining and naming themes	In this phase, the researcher defines and refines the themes to present the data analysis appropriately (Braun & Clarke, 2006). For both the CIL data extraction and the interviews, the researcher non-simultaneously a) checked for commonalities in the themes. b) then linked the codes and formed relationships between the codes to complete the network diagram.
6	Phase 6: producing the report	Phase 6 begins when one has a set of fully worked-out themes and involves the final analysis and write-up of the report (Braun & Clarke, 2006). a) CIL data extraction – the researcher wrote up the findings of the data extracted from the CIL (the findings are discussed in section 5.3). b) Interviews – the researcher wrote up the findings of the data collected from the interviews (the findings are discussed in Chapter 6)

Coding, in its most basic form, is the simple operation of identifying segments of meaning in the data and labelling them with a code (Skjott & Korsgaard, 2019). A code may be defined

as “a word or short phrase that symbolically assigns a summative, salient, essence-capturing and/or evocative attribute for a portion of language-based or visual data” (Saldaña, 2015, p. 3). Codes are created to understand the phenomenon and/or the participants and their perspectives (Skjott & Korsgaard, 2019).

The two major approaches to coding are inductive and deductive coding (Adelowotan, 2021; Vila-Henninger, 2019). Inductive coding refers to generating codes from relevant information identified in the data, while deductive coding uses theoretical concepts or themes from the existing literature (Adelowotan, 2021; Skjott & Korsgaard, 2019). The researcher chose an inductive coding approach for this study because the data extracted from the CIL and captured from the interviews had not been analysed previously. Therefore, the researcher needed to understand the data before analysing this information. Accordingly, an inductive approach stays more loyal to the data and gives voice to it (Skjott & Korsgaard, 2019).

Section 4.4.6 presents the concepts related to the validity and reliability of the data.

4.4.6. Validity and Reliability

Research methodology is judged for rigour and strength based on the validity and reliability of the research (Morris & Burkett, 2011). Reliability and validity are essential and fundamental features for good research when evaluating any measurement instrument or tool (Mohajan, 2017; Tavakol & Dennick, 2011). These are important concepts in modern research, as they enhance the accuracy of the assessment and evaluation of research work (Tavakol & Dennick, 2011). Section 4.4.4.1 presents validity while section 4.4.4.2 presents the reliability of the study.

4.4.6.1. Validity

Validity concerns what an instrument measures and how well it does so (Mohajan, 2017; Robson & Kieran, 2016). So, validity requires a research instrument to correctly measure the concepts being studied (Pallant, 2013). Validity encompasses the entire experimental concept and establishes whether the results obtained meet all the requirements of the scientific research method (Mohajan, 2017); in other words, whether a research technique (implemented during data collection) truly represents what the researcher is claiming to measure (i.e. accuracy) (Heale & Twycross, 2015). For example, suppose the study aims to evaluate whether users use the BI banking reports without any usability issues. In that case, the survey is appropriate for testing and presenting the scores. As a result, validity is a compulsory requirement for all types of study (Oliver, 2010).

There are many types of validity (Cornell, 2008) such as content, construct, criterion (Heale & Twycross, 2015) and convergent validity (Cornell, 2008). This study applied convergent validity.

Convergent validity is a concept to demonstrate a substantial and significant correlation between instruments designed to assess a common construct (Duckworth & Kern, 2011) and reflects the way two measures capture such a construct (Carlson & Herdman, 2010). To test the validity of all the dimensions in the questionnaire, a factor analysis was used. Factor analysis operates on the notion that measurable and observable variables can be reduced to fewer latent variables that share a common variance (Bartholomew et al., 2011). Factor analysis was used to determine whether the individual questions contributed to their corresponding constructs as contained in the questionnaire.

4.4.6.2. Reliability

Reliability relates to the consistency of a measure (Berchtold, 2016; Elliott et al., 2020; Heale & Twycross, 2015) under similar circumstances (Berchtold, 2016; Elliott et al., 2020). In other words, reliability is the capacity of a test to replicate the exact sequencing between respondents when measured twice (Berchtold, 2016). Since reliability underlies the accuracy and adequacy of a measure (Noble et al., 2019), Cronbach's alpha coefficient is used for estimating the internal consistency of an instrument (Heale & Twycross, 2015). This is done by testing the reliability of the questionnaire. Applying this test specifies whether the items for each dimension are internally consistent and whether they can be used to measure the same construct or dimension of a construct (Al Karim & Chowdhurry, 2014).

Heale and Twycross (2015) indicate the three attributes of reliability: homogeneity, stability and equivalence.

- Homogeneity (or internal consistency) – the extent to which all the items on a scale measure the same construct.
- Stability – the consistency of results using an instrument with repeated testing.
- Equivalence – consistency among the responses of multiple users of an instrument or alternate forms of an instrument.

Section 4.4.7 discusses praxis, the third P of the MMR framework.

4.4.7. Praxis

The third P of the five Ps of MMR is praxis, which, according to Creswell (2010), refers to the adoption and use of mixed methods. Praxis involves the practical application of theory (Cameron, 2010). The most critical issue in this respect is related to methodological and data

integration in MMR (Cameron, 2010). Mixed methods involve combining or integrating qualitative and quantitative research and data in a research study (Creswell, 2014).

Multiple designs exist, including convergent parallel mixed methods, explanatory sequential mixed methods and exploratory sequential mixed methods (Creswell, 2014). The method deemed suitable for this study was explanatory sequential mixed methods because the researcher will first conduct quantitative research, analyse the results and then build on the results to explain them in more detail using qualitative research (Creswell, 2014).

Section 4.4.8 discusses proficiency, the fourth P of the MMR framework.

4.4.8. Proficiency

The fourth P of the five Ps of MMR is proficiency. Proficiency relates to the competency of the research conducted by the researcher, which becomes a challenge because MMR is inclusive of both qualitative and quantitative methods (Cameron, 2010; Hall, 2013) and therefore requires both qualitative and quantitative research skills (Cameron, 2010; Creswell, 2014).

Section 4.4.9 discusses publishing, the fifth P of the MMR framework, publishing.

4.4.9. Publishing

Generally, the outcomes of the entire research process should be reported to the relevant audience (Benkharafa, 2013). Thus, the fifth P of the five Ps of MMR is publishing. Cameron (2010) argues that the last of the Five Ps relates to the politics of publishing mixed methods and represents the last challenge to those engaged in MMR. As a result, the researcher should try to present the study, the results and his/her interpretations as clearly as possible to the relevant audience (Benkharafa, 2013).

The researcher aims to produce a research paper that will be presented at a conference and published in the conference proceedings. The study results will be produced as a dissertation, in partial fulfilment of the need to communicate the findings to the relevant audiences.

Section 4.9 gives a summary of Chapter 4.

4.5. Summary

Chapter 4 was dedicated to the research design and the research method employed in this study. The philosophical paradigm that guided this study was pragmatism, because this allows for the use of MMR to explore BI banking report usability. The worldview applied allowed for the data gathering to be implemented in sequentially (first the survey, then the CIL data extraction and lastly the interviews).

The next chapter outlines the findings of the survey and the CIL data extraction.

CHAPTER 5 : SURVEY AND COMPANY ISSUE LOG DATA EXTRACTION

5.1. Introduction

Chapter 4 presented the research design and methodology applied in this study. Three data-collection methods were discussed: a survey, CIL data extraction and interviews. This chapter provides details on the data analysis and presents the results for each of the survey and CIL data extraction data sets.

Figure 5.1 depicts the chapter layout; section 5.2 reports the findings based on the results of the survey; section 5.3 reports on the BI banking report issues based on the findings of the CIL data extraction collected from the CIL; and section 5.4 presents a summary of the chapter.

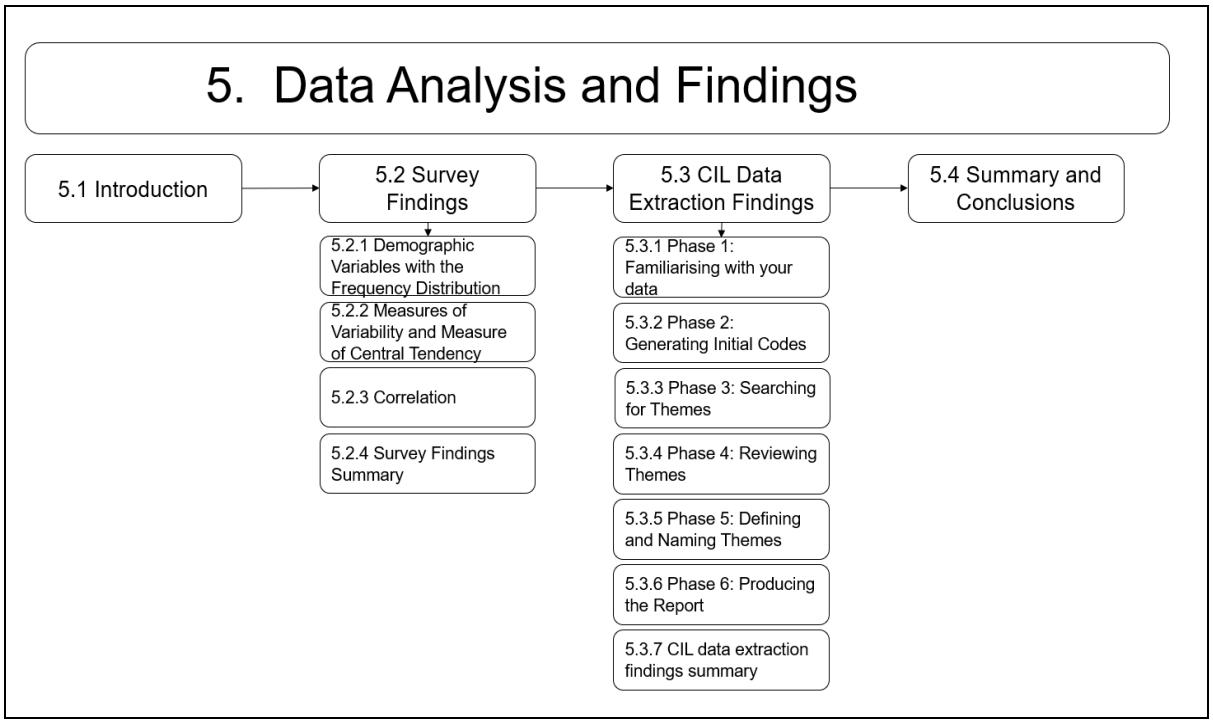

Figure 5.1: Chapter Layout

5.2. Survey Findings

This section focuses on the survey results that were analysed to identify the usability criteria that should be used to evaluate BI banking reports from the users' perspective against the literature-based usability criteria (LBUC) identified in Chapter 3 (section 3.8). Section 5.2.1 presents the demographic variables with the frequency distribution, while section 5.2.2 presents the measures of variability and measure of central tendency. Section 5.2.3 presents the correlations of the study and, lastly, section 5.2.4 provides a summary of the survey findings.

5.2.1. Demographic Variables with the Frequency Distribution

A total of 274 questionnaires were distributed, of which 98 were returned. The demographic information on the 98 participants is shown in Appendix F. Figures 5.2 to 5.5 illustrate the sample distribution by age, language, BI user and experience in the BI sector. Regarding gender, 58 males formed 59.2% and 40 females formed 40.8% of the sample.

Figure 5.2 depicts the sample distribution by age. Most of the participants (63.3%) fell within the age group of 25–34 years, followed by the 35–44 years age group (28.6%), while the 45 and above years age group accounted for 5.1% and those between 18 and 24 years of age accounted for 2%. One per cent of the population preferred not to say.

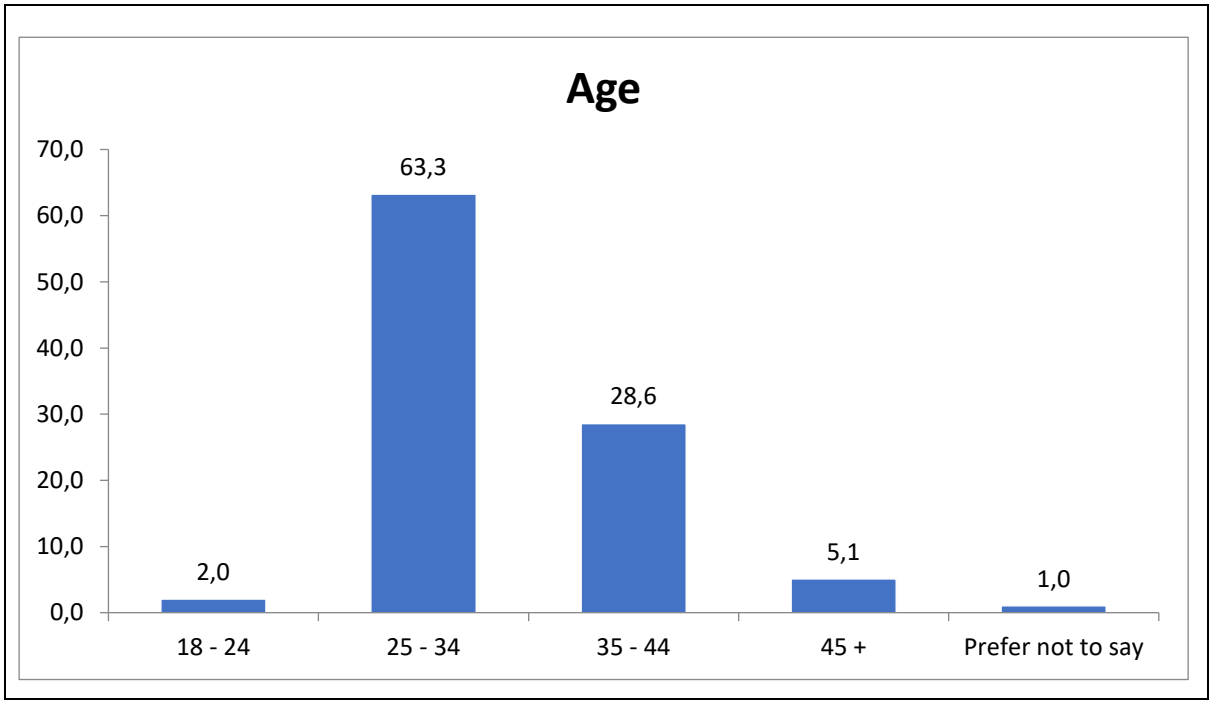

Figure 5.2: Sample Distribution by Age

Figure 5.3 depicts sample distribution by language. The highest percentage in terms of language was English (27.6%), followed by isiZulu (14.3%), both Sesotho and Setswana speaking participants had a similar percentage of 12.2%, followed by isiXhosa (10.2%) and Xitsonga (7.1%). The Afrikaans and Sepedi-speaking participants had a similar percentage of 6.1%, followed by siSwati (2%) and isiNdebele (1%). One per cent of the population preferred not to state their home language.

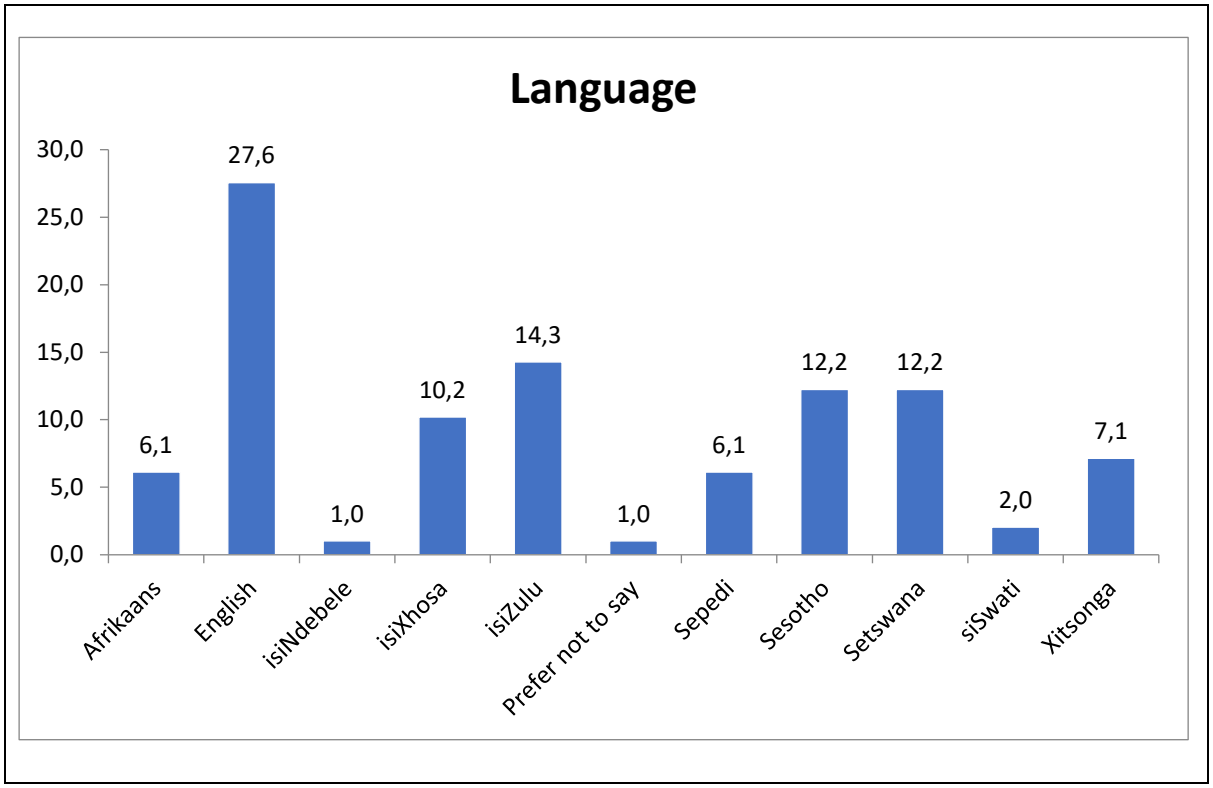

Figure 5.3: Sample Distribution by Language

Figure 5.4 depicts the sample distribution by BI user experience. Considering BI use experience, the largest group (45.9%) had been BI users for 49 and above months, followed by 25–48 months as a BI user (21.4%) and 13–24 months as a BI user (17.3%). This was followed by 0–3 months as a BI user (10.2%) and, lastly, 4–12 months as a BI user (5.1%).

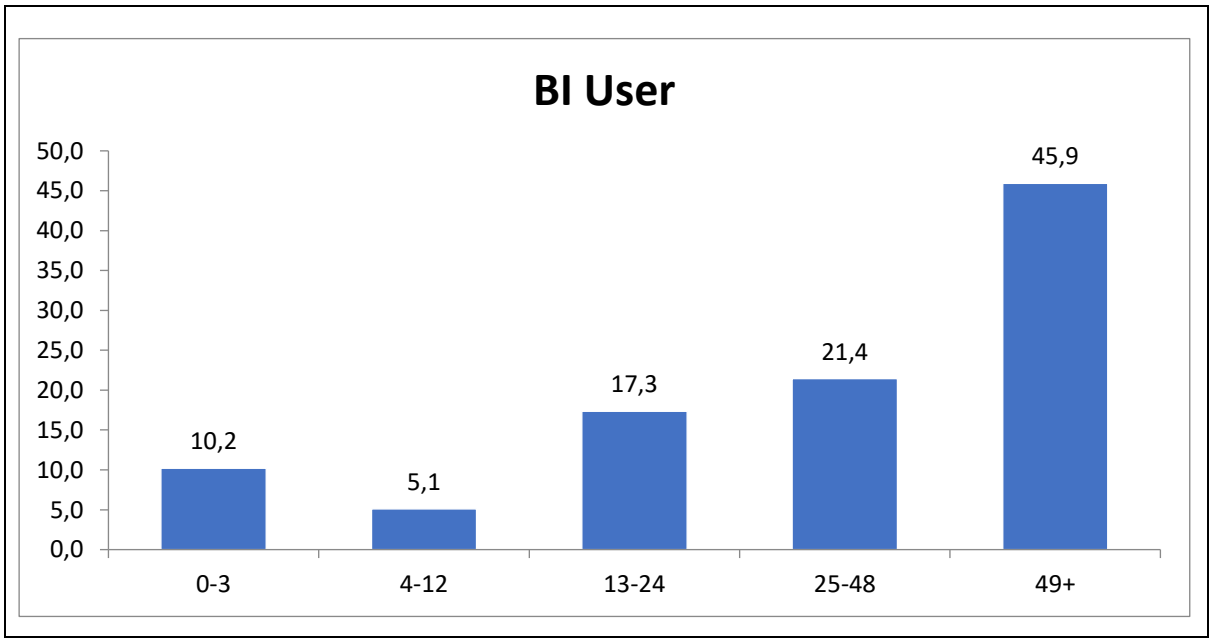

Figure 5.4: Sample Distribution by BI User Experience

Figure 5.5 illustrates the BI areas in which the users had experience. Most of the participants (38.8%) had experience with both BI reports and dashboards, followed by those with only experience in the BI area of dashboards (9.2%), those with experience in OLAP cubes, data mining, catalogues, reports and dashboard BI areas (8.2%), and those with experience in reports only (7.1%) (see Appendix F for further comparisons). Many of the participants (79.6%) had used the BI system, while 13.3% were unsure and 7.1% had not used it.

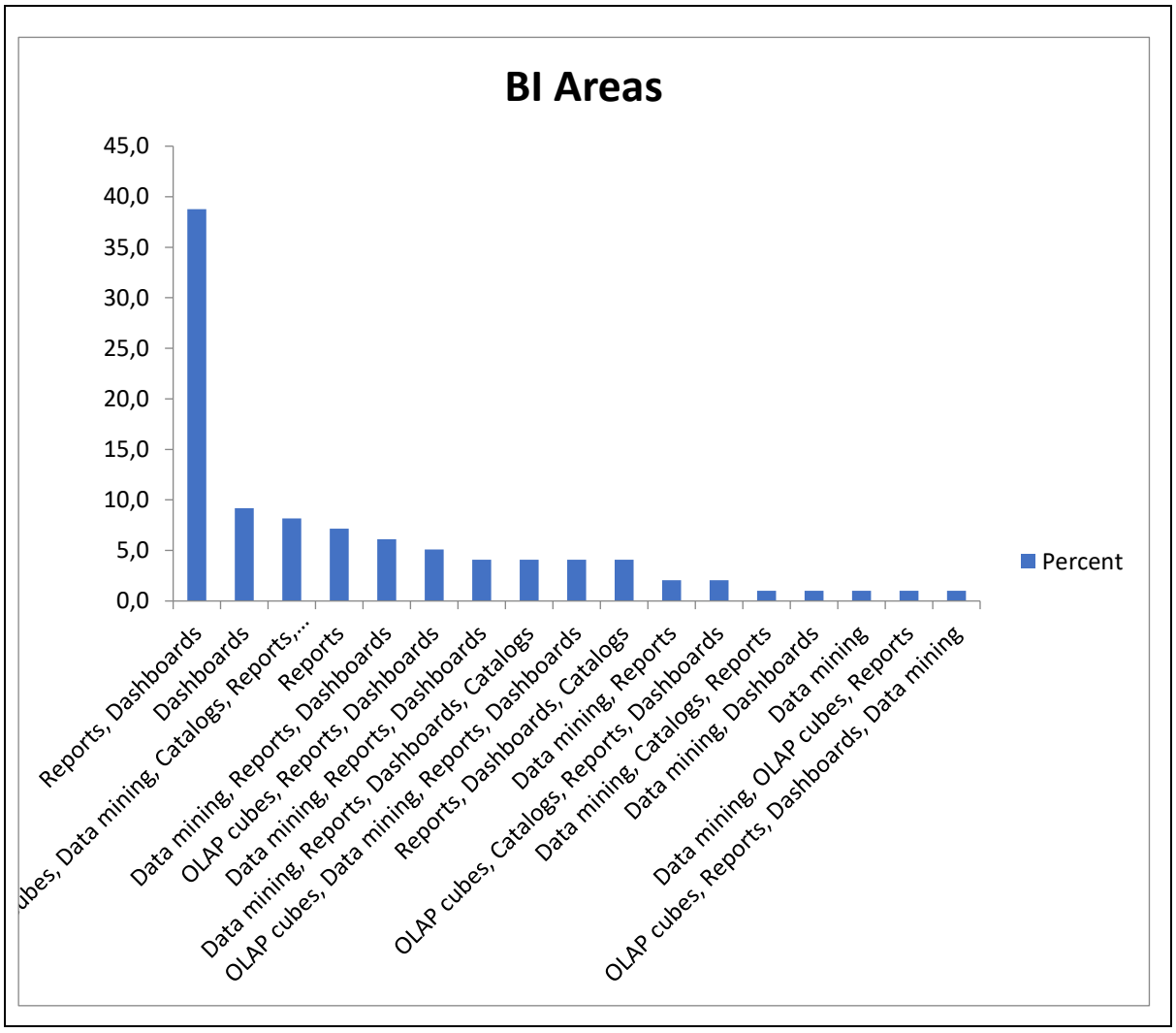

Figure 5.5: BI Areas

Section 5.2.2 presents the measures of variability and the measure of central tendency.

5.2.2. Measures of Variability and Measure of Central Tendency

The mean and standard deviations for the learnability, robustness, design, flexibility and usability goals are illustrated in Table 5.1. A Likert scale was used to describe the frequency of the different variables, where 1 represents ‘strongly disagree’, 2 ‘disagree’, 3 ‘neutral’, 4 ‘agree’ and 5 ‘strongly agree’.

Table 5.1: Measures of Variability and Measure of Central Tendency

Constructs	N	Minimum	Maximum	Mean	Std. Deviation
Learnability	98	1.00	5.00	3.8878	0.62213
Robustness	98	1.00	5.00	3.6122	0.68312
Design	98	1.00	5.00	3.9252	0.61208
Flexibility	98	1.00	5.00	3.6939	0.67210
Usability Goals	98	1.00	5.00	3.9184	0.62234
Valid N (listwise)	98				

Considering Table 5.1 Measures of variability and measure of central tendency:

- The mean for learnability is 3.8878. This means that most of the sampled population rated the learnability of the reports above average. Furthermore, this indicates that their prior knowledge of banking reports helped them to use the reports.
- The mean for robustness is 3.6122. This means that most of the sampled population agreed that it was easy to recover the work after an unexpected situation, for example a power cut, and that it is easy to take corrective action (e.g. undo) once the error was recognised. Additionally, the report site provided feedback to indicate continued progress.
- The mean for design is 3.9252. This means that most of the sampled population agreed that the report design showed relevant information and functionalities and provided informative responses to the user.
- The mean for flexibility is 3.6939. This means that most of the sampled population agreed that users could customise the report according to their priorities.
- The mean for usability goals is 3.9184. This means that most of the sampled population agreed that the report provided users with the information they require to achieve their goals and that the report assists users in completing their tasks on time.

In summary, all the values become 4 when rounded to the nearest integer. Therefore, the findings indicate no significant dissatisfaction with the usability of the BI banking reports as measured by these constructs.

Section 5.2.3 presented correlations between constructs.

5.2.3. Correlations

For this study, correlations were aimed at quantifying the degree to which two constructs were related. Accordingly, Pearson product-moment correlation was used for this purpose. These correlations measure a linear association between two normally distributed random variables (Schober & Schwarte, 2018). For this study, $p < 0.05$ was considered statistically significant, as advocated by Eze et al. (2019) and Pandya et al. (2016). All the constructs and their relationships have a p-value of < 0.05, which means that the correlations between the constructs were highly significant, except for learnability and flexibility which had a p-value of 0.005, which indicates a significant correlation. Table 5.2 presents the correlations. The findings confirm that all the variables are correlated; this may suggest that they all contribute to the usability of the BI banking reports, but more confirmation is necessary.

Table 5.2: Correlations

Constructs		Learnability	Robustness	Design	Flexibility	Usability
Learnability	Pearson's Correlation (r)	1	.430**	.615**	.279**	.547**
	Sig. (2-tailed) (p)		0.000	0.000	0.005	0.000
	N	98	98	98	98	98

Constructs		Learnability	Robustness	Design	Flexibility	Usability
Robustness	Pearson's Correlation (r)	.430**	1	.415**	.405**	.477**
	Sig. (2-tailed) (p)	0.000		0.000	0.000	0.000
	N	98	98	98	98	98
Design	Pearson's Correlation (r)	.615**	.415**	1	.466**	.721**
	Sig. (2-tailed) (p)	0.000	0.000		0.000	0.000
	N	98	98	98	98	98
Flexibility	Pearson's Correlation (r)	.279**	.405**	.466**	1	.580**
	Sig. (2-tailed) (p)	0.005	0.000	0.000		0.000
	N	98	98	98	98	98

Constructs		Learnability	Robustness	Design	Flexibility	Usability
Usability	Pearson's Correlation (r)	.547**	.477**	.721**	.580**	1
	Sig. (2-tailed) (p)	0.000	0.000	0.000	0.000	
	N	98	98	98	98	98
**. Correlation is significant at the $P < 0.05$ level (2-tailed).						

Section 5.2.4 presents a summary of the survey findings.

5.2.4. Summary of the Survey Findings

This section discusses the use of descriptive statistics and correlations to analyse the survey data. All the LBUC usability constructs evaluated scored above 3.5. These were then rounded off to the nearest whole number. i.e. 4. This means that most of the participants were satisfied with the BI banking reports as measured by the said constructs. The correlations for all the constructs in Table 5.2 were highly significant except for the correlation between learnability and flexibility, with was found to be significant. This means that the change in one construct effects the change in the other and that the constructs are all related.

To answer RSQ3, the researcher did not drop any usability criteria from the LBUC and subsequently utilised the LBUC to evaluate the BI banking reports from the user's perspective (BIBRUCUP) using interviews to do so. Figure 5.6 depicts the progression of the usability criteria from a set of LBUC to a set of empirically evaluated business intelligence banking reports usability criteria from a user's perspective (BIBRUCUP).

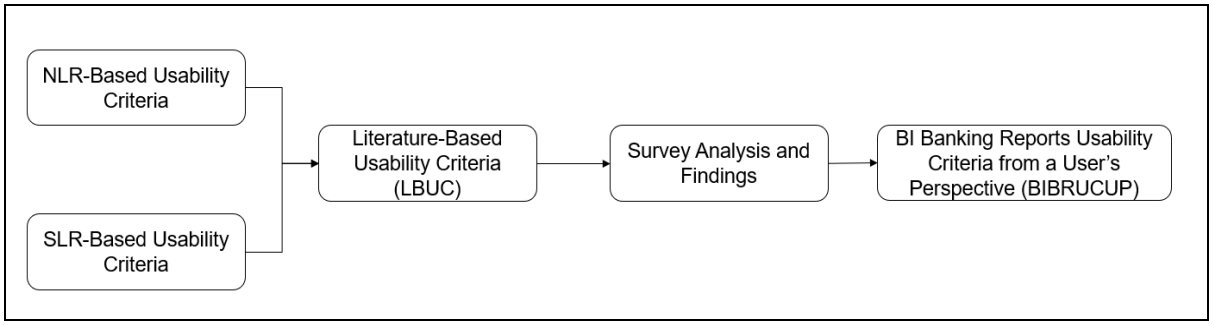

Figure 5.6: BIBRUCUP Progression (Created by Author)

Section 5.3 presents the CIL data extraction.

5.3. Company Issues Log Data Extraction Findings

This section focuses on presenting the findings related to issues reported in regard to the BI banking reports. These issues were extracted from the CIL to identify the potential challenges faced by stakeholders when using the BI reports. The issues were mapped to the LBUC identified in Chapter 3, section 3.8 (Table 3.7) and used to answer RSQ2.

To analyse the request types listed in Table 5.3, thematic analysis (TA) was conducted using *Atlas.ti* version 22.1.3.0 software. *Atlas.ti* is a software program used for qualitative data analysis, helping researchers manage and analyse unstructured data like interviews and texts.[1] The researcher followed the six-phase TA advocated by Braun and Clarke (2006). These phases, as applied to the analyses related to the CIL data extraction, will be discussed in sections 5.3.1 to 5.3.6.

5.3.1. Phase 1: Familiarising Yourself with Your Data

In this phase the researcher needed to become familiar with the data. Accordingly, they read through the data to gain an understanding of the BI banking report issues that were logged and subsequently extracted from the CIL. Different types of requests can be logged, including the *small project*, *investigation*, *change*, *recurring ad hoc*, *incident*, *maintenance*, *scoping*, *large project* and *data extract,* as listed and described in Table 5.3.

CIL data extraction was conducted from June 2020 to March 2021. Table 5.3 shows that 15 small projects were logged, 51 *investigations*, 69 *change requests*, 50 *data extracts*, 13 incidents, three *recurring ad hoc* requests, five *large projects*, four *maintenance* requests and eight *scoping* requests.

[1] https://atlasti.com

Table 5.3: Summary of BI Issues in the Banking Industry Relating to the BI Reports

No	Request Type	Description	Frequency volume
1	Small project	A *small project* refers to a project size category that is allocated when a project is logged; before a project is allocated a size category, scoping has to be done and a presentation has to be received from the client explaining their requirement on a high level. The committee then votes on the size category of the project and the respective senior managers in the team are responsible for allocating a size category to the project.	15
2	Investigation	The *investigation* refers to situations where the data reflecting on the reports may not be as expected by the client. This may be the result of data integrity issues or other data issues; for example, an error that occurs when the client expects the total number of sales to have increased by 3% but the report shows a spike in the form of a 20% increase. This will then be logged for investigation in order to either validate the 20% increase or identify what may have caused the spike.	51
3	Change request	*Change request* refers to occasions when the client wants to change a report that has already been developed and published. The client may, for example, want to add a business rule, remove a filter, or change the report layout.	69
4	Data extract	The *data extract* theme refers to cases where the client requests once-off data in the form of an MS Excel file. In most cases, this is done via Excel, with clients providing the business rules and the fields they want to see. This type of request is usually a once-off and is often referred to as ad hoc.	50
5	Incident	An *incident* is usually logged when an error occurs when the user wants to view a report. 'Incident' refers to an unplanned event that interrupts the users, for example when there is a network outage and the user cannot access the reports.	13

No	Request Type	Description	Frequency volume
6	Recurring ad hoc	The *recurring ad hoc* theme refers to situations where requests of the same nature/issue keep on being logged by the client.	3
7	Large project	A *large project* is a project size category that is allocated when a project is logged. Before a project is allocated a size, scoping has to be done and the client has to make a presentation explaining their requirement on a high level. The committee subsequently votes on the size of the project. A *large project* is one that requires many resources or one that will take a long time to complete. The senior managers in the team are responsible for allocating a size category to the project.	5
8	Maintenance	The *maintenance* theme refers to a maintenance issue, for example server- and database-related issues. Maintenance refers to ensuring that the applications, such as MS PowerBI, Tableau & MyBI, being used are in good working order. Maintenance needs to be done so that business as usual is not affected, i.e. a business can continue to use the reports without getting any errors.	4
9	Scoping	*Scoping* is done for all new projects that need to be classified according to size category by the committee. A client logs this type of request and is then allocated to a business analyst who will document this *scoping*. The level of detail and the client's requirements will help the committee to classify the size of the project as small, medium, large or extra-large.	8

Creation of Project in Atlas.ti

To analyse the data *in Atlas.ti*, the researcher created a new project and named it 'CIL project'. This CIL project was used to store all the project files for this project. The CIL project created in *Atlas.ti* was linked to a container housing the nine documents created based on the request types showed in Table 5.3. These nine documents were created using MS Word before

uploading them to *Atlas.ti*. Figure 5.7 depicts the *Atlas.ti* used by the researcher together with the number of documents uploaded, the initial codes created and the code groups.

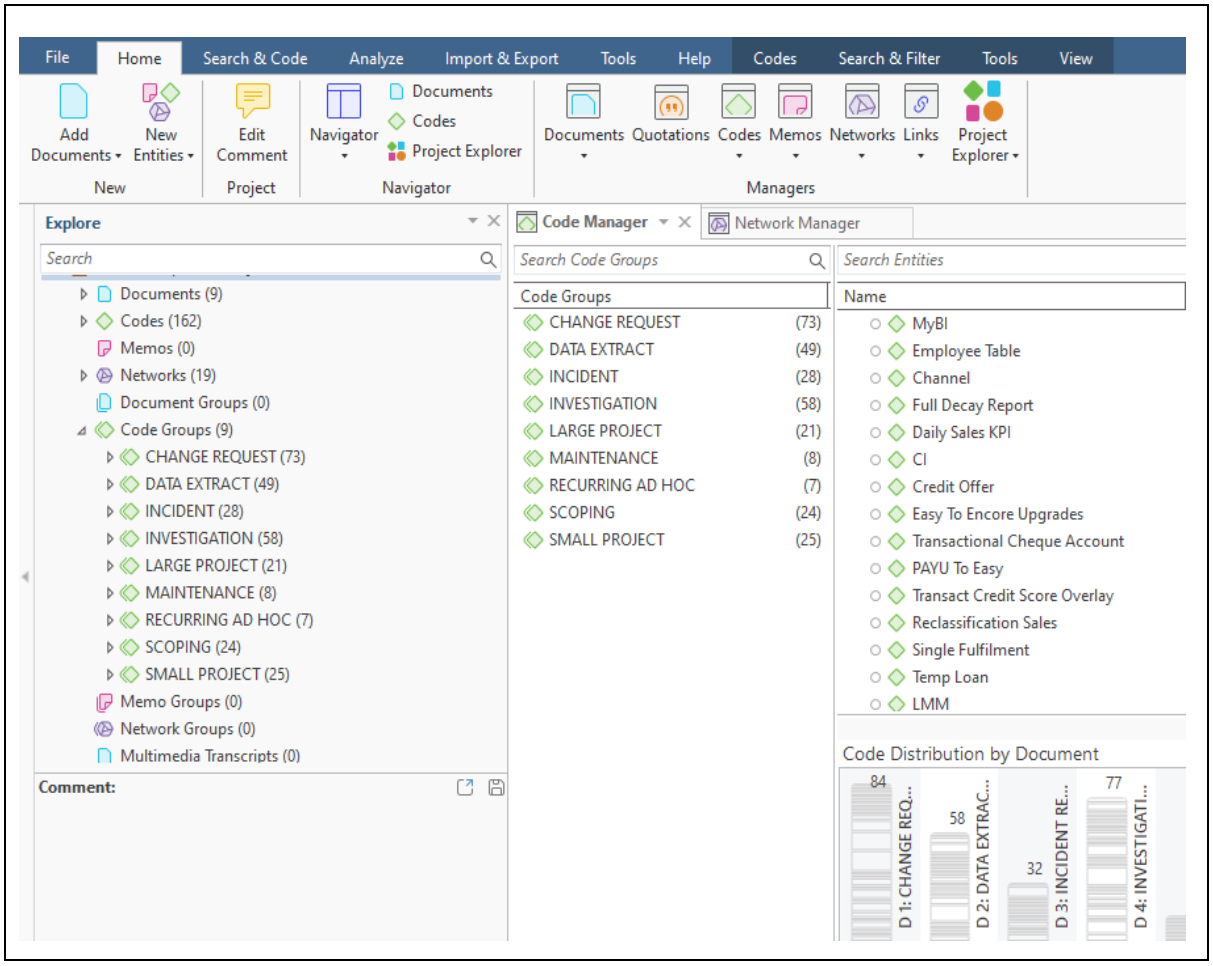

Figure 5.7: Sample *Atlas.ti* Screen

Section 5.3.2 discusses Phase 2, which refers to the initial codes that were generated.

5.3.2. Phase 2: Generating Initial Codes

The second phase involved generating initial codes based on the CIL data. Adelowotan (2021) and Saldaña (2016) define a qualitative code as a word or short phrase that symbolically assigns a summative, salient, essence-capturing and/or evocative attribute to a portion of data. This phase involved reviewing the data from the documents, line item at a time and creating initial codes using specific words or text strings from the documents.

One hundred and sixty-two initial codes were created for this study in *Atlas.ti*. After creating the initial codes, the researcher checked whether they had been added to the code list by clicking on the codes on the navigator panel of *Atlas.ti* in order to view all the codes created. Figure 5.8 depicts a subset of the code names with the estimated number of times that they

appear in the code groups in brackets. The full set of codes can be found in Appendix E. This was done to ensure the accuracy of the initial codes created and to ensure that no codes were accidentally not captured. The researcher reviewed the initial codes to check whether any of them referred to the same thing (duplicated codes) and, if so, ensured that they were collapsed into unique codes. Additionally, codes that gave away the bank name, such as the product name, were anonymised using numbers, for example the product X report was anonymised by referring to it as the product 1 report.

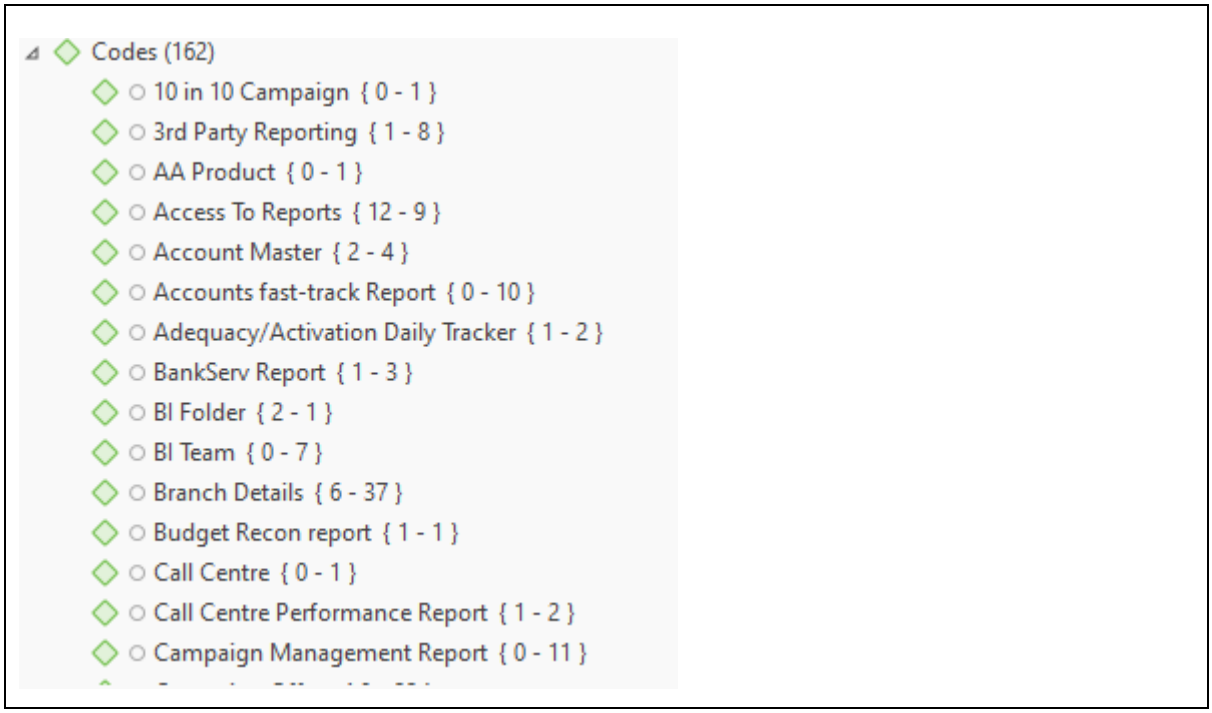

Figure 5.8: List of Initial Codes Extracted from *Atlas.ti*

Section 5.3.3 discusses Phase 3, which refers to the search for themes.

5.3.3. Phase 3: Searching for Themes

The third phase involved searching for themes and engaging with the initial codes (from the second phase) by collating all related, relevant data extracts, as advocated by van Biljon and Mwapwele (2023). Generating themes requires the researcher to collate initial codes into potential themes, grouping all codes relevant to the theme, as Scharp and Sanders (2019) and Vaismoradi et al. (2013) advise.

To create the themes for the CIL data, the researcher used the request types as per Table 5.3. These request types have already been classified in the CIL. From the documents (refer to section 5.3.1.1), nine networks and nine code groups were created. The captured codes were allocated to the relevant code groups to be able to create network diagrams. The names for both the network diagrams and code groups are similar to those allocated to the documents.

This was done to ensure that the codes were allocated to the relevant code group and mapped to the right networks and to ensure the consistency of the network diagrams. For example, for the code group called ‘Changed request’ there is a corresponding network called ‘Changed request’ (see Figure 5.9).

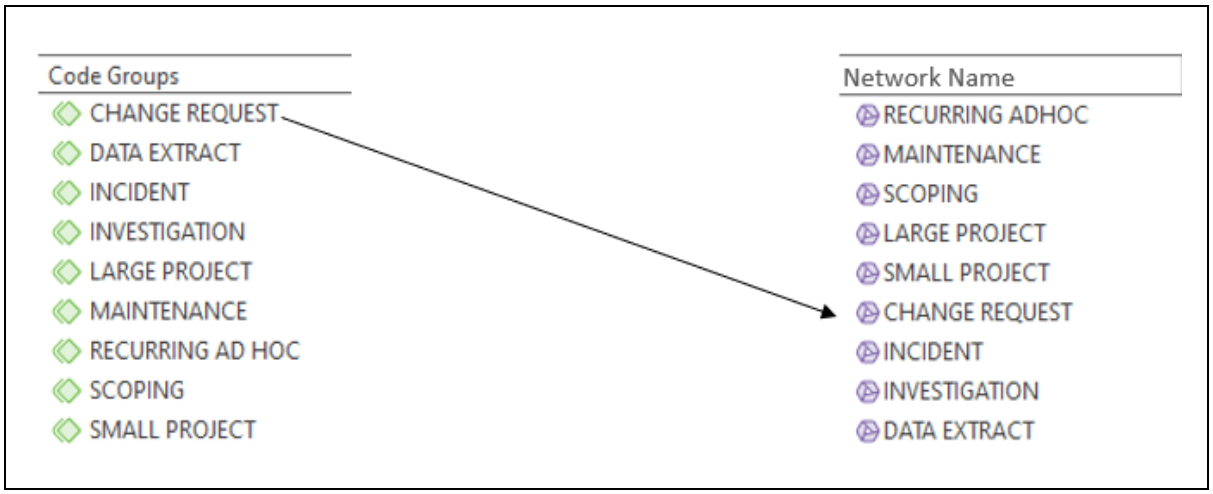

Figure 5.9: Code group with respective network name

Section 5.3.4 discusses Phase 4 in which the themes are reviewed.

5.3.4. Phase 4: Reviewing Themes

The fourth phase focuses on refining the code groups, with each being assessed for internal homogeneity and external heterogeneity as advocated by Braun and Clarke (2006). In this phase the researcher reviewed the allocated codes as well as the code groups. The researcher also revisited the codes allocated to each code group and ensured that the relevant codes were allocated to the correct groups. Of the 162 codes that were initially created (as discussed in section 5.3.2), 75 codes were retained. Subsequently, the codes that were not directly related to BI banking reports and BI banking report issues were removed, as they merely provided general information about the BI banking reports and issues. For example, codes such as ‘channel’ and ‘product type’ were removed. The complete list of 75 codes together with their descriptions can be found in Appendix E.

Section 5.3.5 discusses the themes that were defined and named in Phase 5.

5.3.5. Phase 5: Defining and Naming Themes

The fifth phase involved defining and naming the themes obtained during Phase 4, as advocated by Braun and Clarke (2006) and Scharp and Sanders (2019). In this phase, the thinking behind the code groups was reconsidered based on Phase 1, which involved data capturing and familiarisation with the data. In the end, the researcher did not change any of

the code groups and they remained the same as in Phase 4. Figure 5.10 depicts a network diagram in *Atlas.ti*, showing the nine CIL data themes which include *Investigation*, *Maintenance*, *Change request*, *Incident*, *Small project*, *Large project*, *Data extract*, *Scoping* and *Recurring ad hoc*.

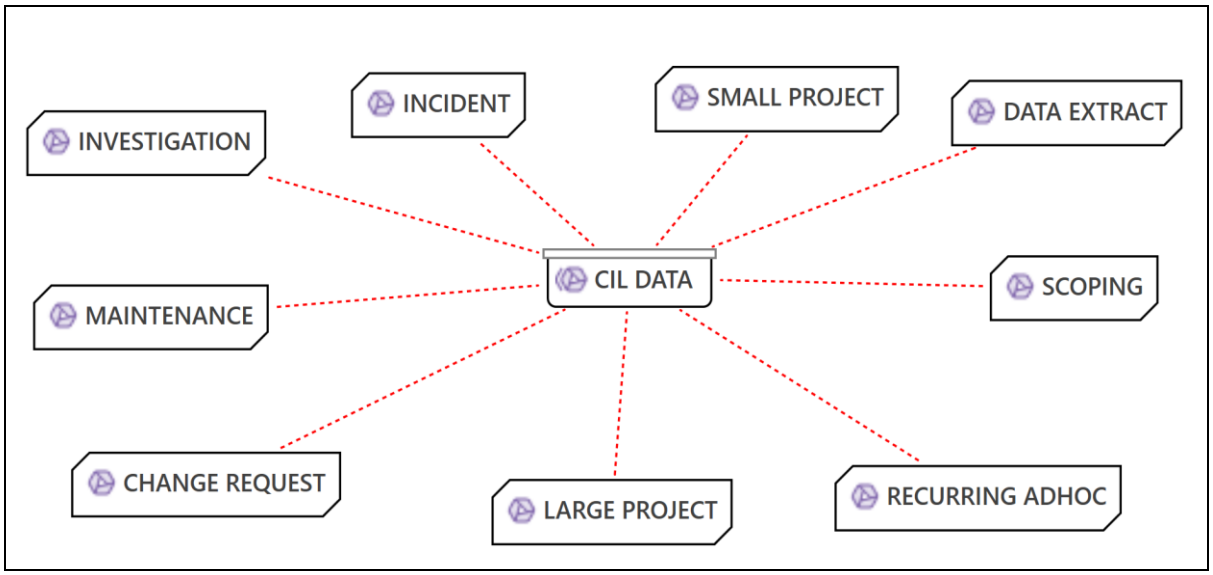

Figure 5.10: Network Diagram Showing the Themes for CIL Data Extraction

Section 5.3.6 discusses the report findings on the BI banking reports usability criteria (BIBRUC), as presented in Phase 6 of the data analysis.

5.3.6. Phase 6: Producing the Report

The sixth phase involved producing the research report – a complete data-based story to allow the reader to understand the merit and validity of the analysis. Network views for each theme were generated by *Atlas.ti* to digitalise and make visible critical thoughts – deliberately or instinctively – and to allow for the further exploration of relationships between different facts, occurrences, observations and reflexivity, as advocated by Friese (2019). Network views assist in visualising any links created during the coding, as well as with commenting and memo writing (Soratto et al., 2020). Code groups are beneficial for retrieving and analysing data; their primary purpose is to serve as filters, which also assist in building the coding frame (Soratto et al., 2020).

Network views will now be discussed by considering the issues that users experience with the BI report for each theme. The BI reports and the related issues will be identified. To differentiate between the theme name and a code, a theme is depicted in uppercase letters in all the network diagrams and the words in a code are capitalised. Figure 5.11 depicts the legend used for the code relationships for all the networks. Please note that due to *Atlas.ti*

limitations, only a few colours were selected for the relationships, resulting in the same colour being used twice while the relationship line style is depicted differently. Another limitation pertains to the relationship name, as there were only three options to choose from: the full relationship name which clusters the network diagram, the symbol, and the short name. For the network diagrams in this study, we have chosen the short name, for example 'A', which is short for 'Contradicts'. Because of this limitation, only a few of the relationship short names chosen will show on all the network diagrams (see Figures 5.12 to 5.20). The relationship labelled with the short name is depicted because the relationships were inherited from *Atlas.ti*. As a result, there will be instances in the network diagram where the short name is shown for some relationships and others where the short name is absent.

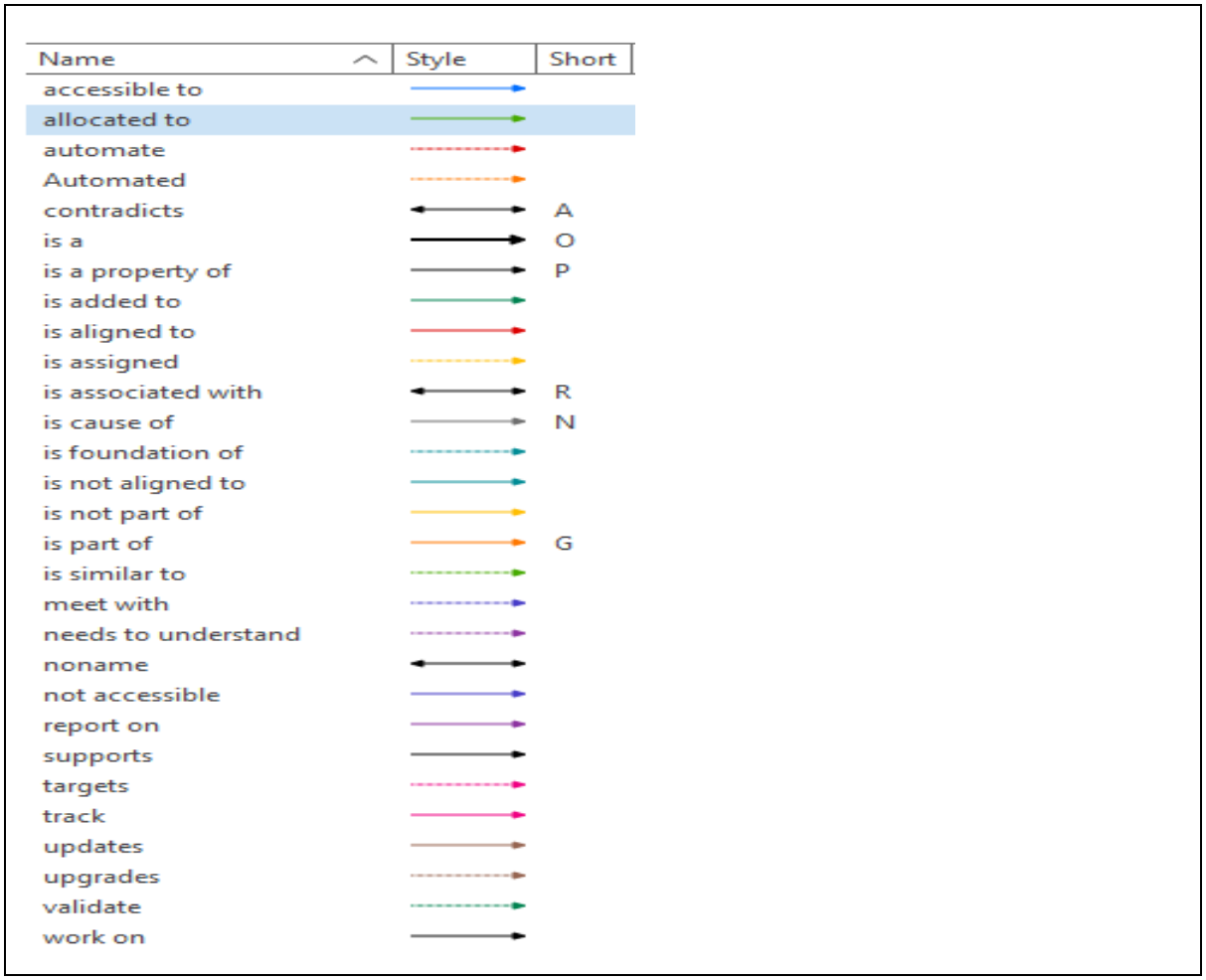

Figure 5.11: Legend Used for The Code Relationships for All the Networks

5.3.6.1. Recurring ad hoc

According to Figure 5.12 for the *Recurring ad hoc* theme, four codes were identified. Table 5.4 shows the codes and the descriptions together with an indicator, indicating whether the code refers to a report or to a BI issue.

Table 5.4: Recurring ad hoc Code and Code Descriptions

No	Code	Code description	BI report (R), BI issue (I)
1	Adequacy/activation daily tracker	This is a code for a report; in this case, the report in which the request is logged to enable it to be resolved.	R
2	Product 1 Daily File	A code for a report; in this case, the report in which the request is logged to enable it to be resolved.	R
3	MyBI	A reporting portal where reports are hosted so that users can access their reports in a central location.	R
4	Missing Data	Data that is missing on the reports. This data may have been missing for a particular period and may need to be refreshed in order to update the report.	I

Of the four codes listed, two, namely *Adequacy/Activation Daily Tracker* and *Product 1 Daily File*, relate to the BI reports and the *MyBI portal* used to host these reports. One CIL data extraction issue related to BI reports was found, namely *Missing Data*. The missing data issue code resulted from the data missing from both the *MyBI portal* and the *Product 1 Daily file*.

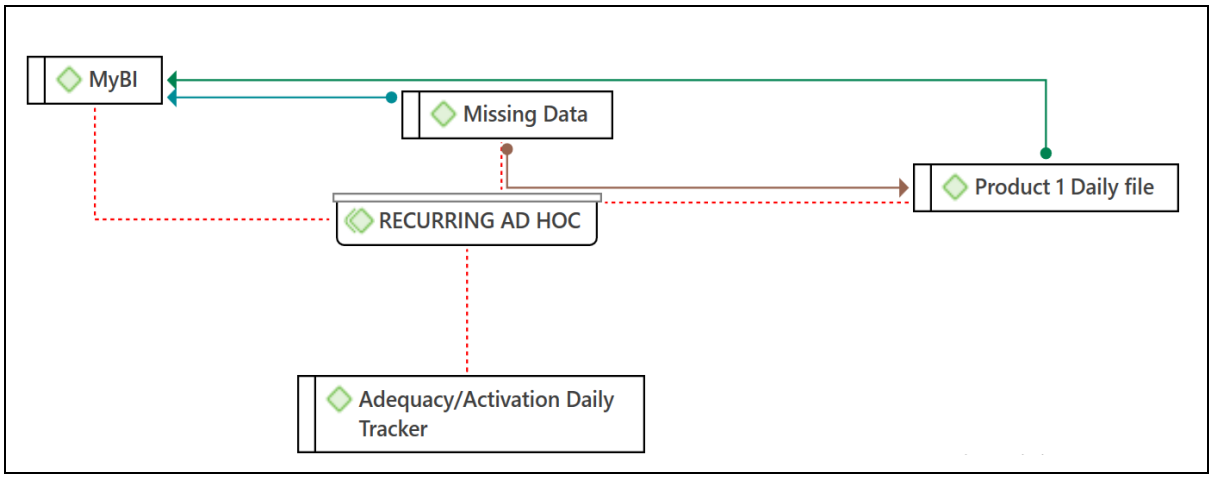

Figure 5.12: Network Diagram – Recurring ad hoc (Author's compilation from *Atlas.ti*)

Based on the CIL data extraction data, the daily report file occurred twice under two different names. The first occurrence was a case where the client needed confirmation as to whether the data displayed on the reports was a true reflection of the data available in the database. On the second occurrence, the client was informed that the data was loaded on the MyBI portal, but the file was empty. This also resonates with the theme of recurring requests.

In summary, the BI report issue in this theme is *Missing Data*. *Missing Data* means that data is missing from the various reports or portals, as depicted in Figure 5.12.

5.3.6.2. Maintenance

According to Figure 5.13, 10 codes related to the *Maintenance* theme were identified. Of the 10 codes, five, namely, *Reclassification Sales report*, *Product 5 Sales Analysis Report*, *product 3 Report*, *Upgrades Report* and *product 2 Accounts Report,* related to the BI reports associated with this theme, as well as the *MyBI* portal used to host these reports. Table 5.5 shows the codes and the descriptions using an indicator that shows whether the code refers to a report or a BI issue. From the codes identified in section 5.3.6.1, some overlaps with the codes used for the *Maintenance* theme were identified; therefore, the code that was part of the *Recurring ad hoc will* not be added as part of the table of codes and descriptions in order to avoid repetition. The same applies to the subsequent sections. The codes will be defined once in the section in which they first appeared.

Table 5.5: Maintenance Code and Code Descriptions

No	Code	Code description	BI report(R), BI issue (I)
1	Upgrades Report	A report in which multiple requests are logged because data is missing or the report is not updated within the given time frame.	R
2	Reclassification Sales Report	A report that tracks sales on a daily basis.	R
3	Product 2 Accounts report	A report code; refers to tracking accounts for a certain product.	R
4	System Issues	A system problem which needs to be resolved.	I

No	Code	Code description	BI report(R), BI issue (I)
5	Product 5 sales Analysis Report	A report that tracks a certain product	R
6	Report Investigation	This means that a gap analysis is required to ensure that the solution is correct or aligned with other solutions with similar key performance indicators (KPIs).	I
7	Enhancement of Reports	This means that the business has certain requirements which now need to be changed, thereby enhancing the report.	I
8	Product 3 Report	A report that is specific to a certain product.	R

One of the reports required an enhancement to be done to include a system and a channel and requested that the rules applied in the report be checked to ensure they were still relevant. The validation of the reports is related to the report's *Investigation* code as a resource. The team consequently needs to verify that the rules are up to date before making any changes to the reports. Furthermore, the codes associated with the reports require the addition of certain fields.

The other standard code identified in this theme is *Missing Data*, which indicates a report with missing data. This report required the addition of a copy of the missing days to the underlying table of the report. Another issue was system issues that may have occurred and affected the reports. This, in turn, requires reports to be updated on the *MyBI* portal. *System Issues* can result in the portal not updating the data for the client.

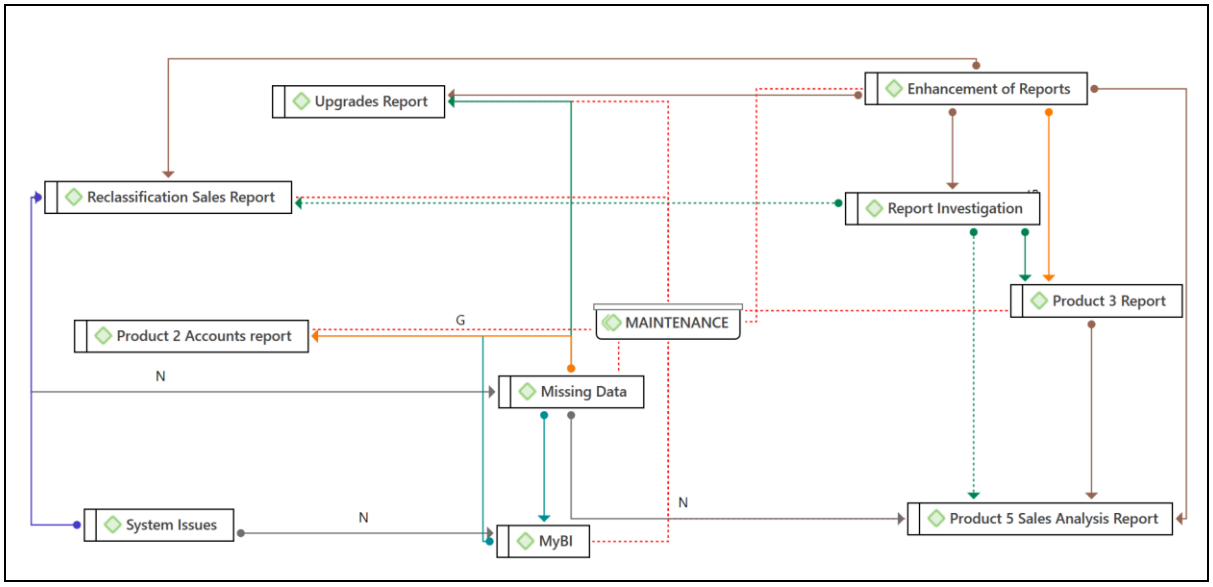

Figure 5.13: Network Diagram – Maintenance (Author's Compilation from *Atlas.ti*)

In this theme, the BI report issues found were missing data, system issues, enhancement of reports and reports investigation.

- *Missing Data,* means that data is missing from the specific report. For example, the Reclassification sales report, upgrades report and Product 5 sales analysis report, as well as MyBI portal reports.
- *System Issues* mean there is an issue with the system, which resulted in the reports not containing up-to-date data.
- *Enhancement of Reports,* means that the business had certain requirements which it subsequently wanted to change. This may be caused by, for example, a change of business rules, the evolution of the business where the stakeholders require certain changes, or the business is dissatisfied with what is being offered.
- *Report Investigation* if due to the client wanting to ensure that the rules applied for the reports are up to date and, if not, to have the reports updated with the latest business rules.

In summary, in this theme, the common BI report issues found were *Missing Data, System Issues, Report Investigation and Enhancement* of *Reports*.

5.3.6.3. Large Project

Table 5.6 shows the codes and the descriptions together with an indicator, indicating whether the code refers to a report or a BI issue.

Table 5.6: Large Project Code and Code Descriptions

No	Code	Code description	BI report(R), BI issue (I)
1	Account Fast-track Report	A report that tracks the products sold to customers.	R
2	Team 2 Monthly Pack Report	This is a monthly pack made up of a lot of different reports.	R
3	Opportunity or Missed report	A report that tracks whether customers who qualified for credit products that were offered to them when they opened an account accepted the offer.	R
4	Product 3 and product 4 report	A report that tracks a certain product. The client has to track whether the customers that hold one product also hold another.	R
5	MFT Feed	A secure file share where files can be transferred by different parties in a location that has been set up in alignment with the security protocols in place.	R
6	Sales Report	A report that tracks sales.	R

According to Figure 5.14, seven codes were identified for the Large Project theme. Five codes were chosen from the seven codes; namely, *Product 3 and Product 4 Report*, *Account Fast-Track Report*, *Opportunity or Missed report*, *Team 2 Monthly Pack report* and *Sales Report* which are all related to the BI reports associated with this theme.

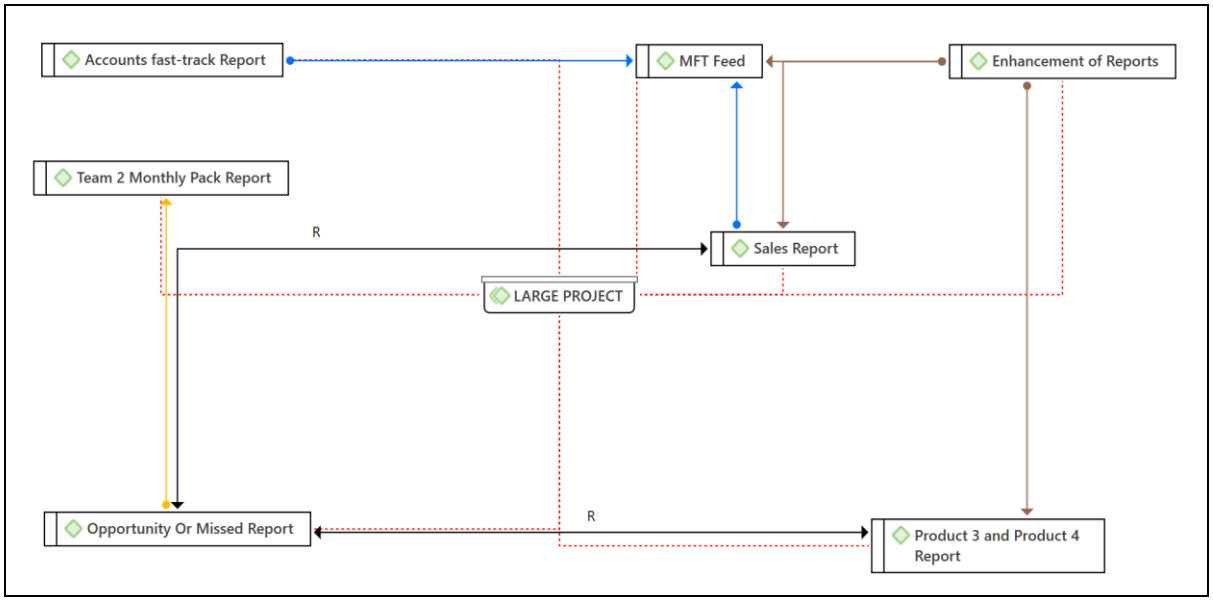

Figure 5.14: Network Diagram – Large Project (Author's compilation from *Atlas.ti*)

Most of the codes for this theme required the automation of reports, apart from one report code which required an *Enhancement of the Report*. As a result, the only issue identified in this theme is the *Enhancement of the Report*. In the details of the request logged, the user specified that the report was an existing report which required enhancements.

5.3.6.4. Scoping

Table 5.7 shows the codes and the descriptions together with an indicator, indicating whether the code is a report or a BI issue.

Table 5.7: Scoping Code and Code Descriptions

No	Code	Code description	BI report(R), BI issue (I)
1	Data source	The data sources used at the back end of the reports.	I
2	Sales Quality report	A report that tracks the quality of accounts sold.	R
3	Data Request	Contains the requests for data extracts. This was supposed to be included in the data extract request type but when the client requested	I

No	Code	Code description	BI report(R), BI issue (I)
		these, they allocated it to an incorrect request type.	
4	Product 7 Sales Report	A report that tracks certain products that are sold to customers.	R
5	New Branch details Report	A report that contains branch information.	R
6	Campaign Management Report	A report that tracks the performance of campaigns.	R
7	3rd Party Reporting	A report that tracks products sold by an external party.	R

As may be seen in Figure 5.15, nine codes were identified for the scoping theme. Of the nine codes, five, namely *Campaign Management Report*, *Product 7 Sales Report*, *Sales Quality Report*, *3rd Party Reporting* and *New Branch Details Report*, related to the BI reports for this theme.

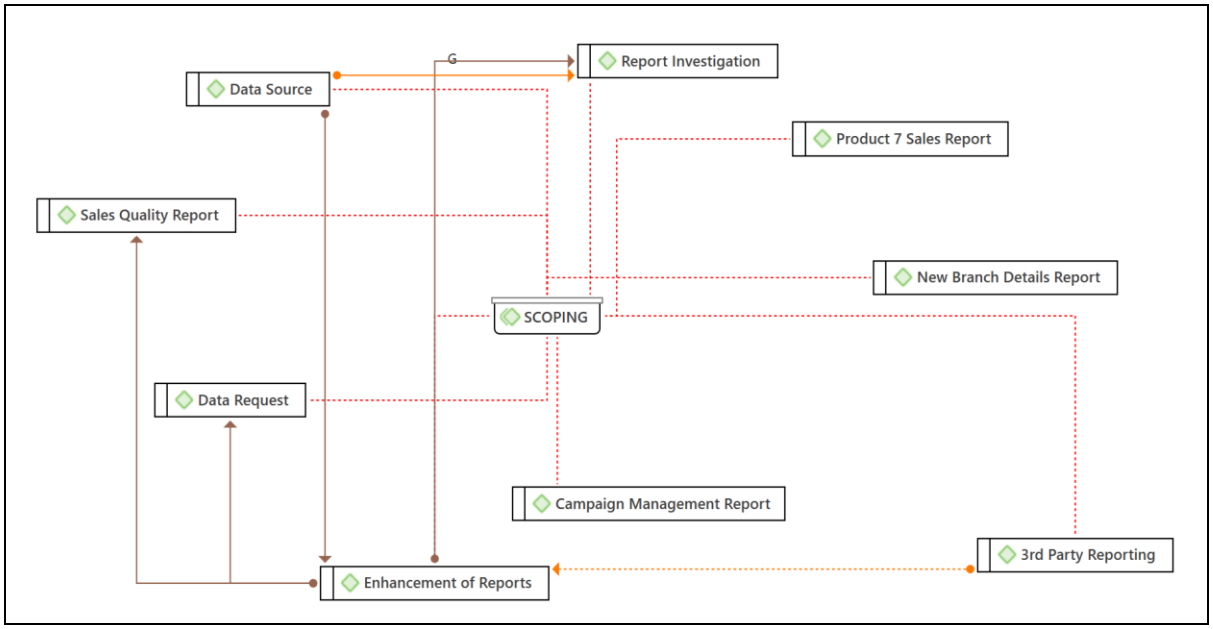

Figure 5.15: Network Diagram – Scoping (Author's Compilation from *Atlas.ti*)

Of the five report codes associated with the reports, three, namely Campaign Management Report, New Branch Details Report and Product 7 Sales Report, were new and were

requested for new development, while two codes of the five, namely, *Sales Quality report* and *3rd Party Reporting* already existed and were linked to the *Enhancement of Reports* code, as changes to them were required. Another change made to these reports was to ensure the alignment of reporting for a business unit. A further change entailed adding additional requirements to the existing report. There are multiple reasons for this, as stated in Theme 2 on maintenance. There were two enhancements of the same report with the same changes, but the ticket number was different, meaning the client may have logged the same request twice.

The other request was for the offers; in this case, where the client could not find the offers they were looking for and wanted to determine the difficulty level to obtain the data they required. While the data they requested exists, it applies to different offers.

The BI report issue identified in this theme is the enhancement of the report to include new requirements following a budget presentation. This can also mean that the scope of the report was broadened to cater for the KPIs gleaned from the budget presentation and the team wanting to start reporting on these. The enhancements of the reports were also probed by the user and thus investigation was needed so that the user could ascertain whether it was feasible to do the enhancements or not.

5.3.6.5. Incident

Table 5.8 shows the codes and the descriptions together with an indicator, indicating whether the code refers to a report or a BI issue.

Table 5.8: Incident Code and Code Descriptions

No	Code	Code description	BI report(R), BI issue (I)
1	Campaign offers Report	A report that tracks offers made to customers.	R
2	Daily Sales Report	A report that tracks daily sales.	R
3	Access to reports	This refers to situations where the customer does not have access to the reports they attempt to view. This can be caused by a system issue, e.g. the report is inaccessible.	I

No	Code	Code description	BI report(R), BI issue (I)
4	Enterprise Value Vintage report	A report that tracks employee performance.	R
5	Slow speed	This refers to the fact that response time when accessing the report or report portal is slow.	I
6	Data quality issues	This refers to the presence of issues in the report data that the client wants to access, e.g. client obtains values they don't expect in certain fields such as a null value.	I
7	BankServ Report	A report that tracks transactions that have taken place.	R
8	Visa Report	A report that tracks a particular card type.	R
9	Team 1 Recon report	A report that tracks overall products movement from inception to the end of the product take-up lifecycle. This report contains many sub-reports.	R
10	Card Base Report	A report that tracks the number of cards.	R
11	Manual Excel Report	This is a manual report.	R

As shown in Figure 5.16, 18 codes were identified for the incident theme. Of the 18 codes, 11, namely *BankServ Report*, *Daily Sales Report*, the *Campaign Offers Report*, *Team 1 Recon Report*, *Card Base Report*, *Manual Excel Report*, *Visa Report*, *Enterprise Value Vintage Report*, *Upgrades Report*, *Reclassification Sales Report* and *Product 5 Sales Analysis Report* were related to the BI reports for this theme. One report code out of the 11 involved a request to build a new report, even though there were already other reports. Some reports required *Enhancement*, some reported *Missing Data*, or slow response times, while still others required *Investigation*, some were not *Accessible* and others had *Data Quality Issues,* for example *the Reclassification Sales report*.

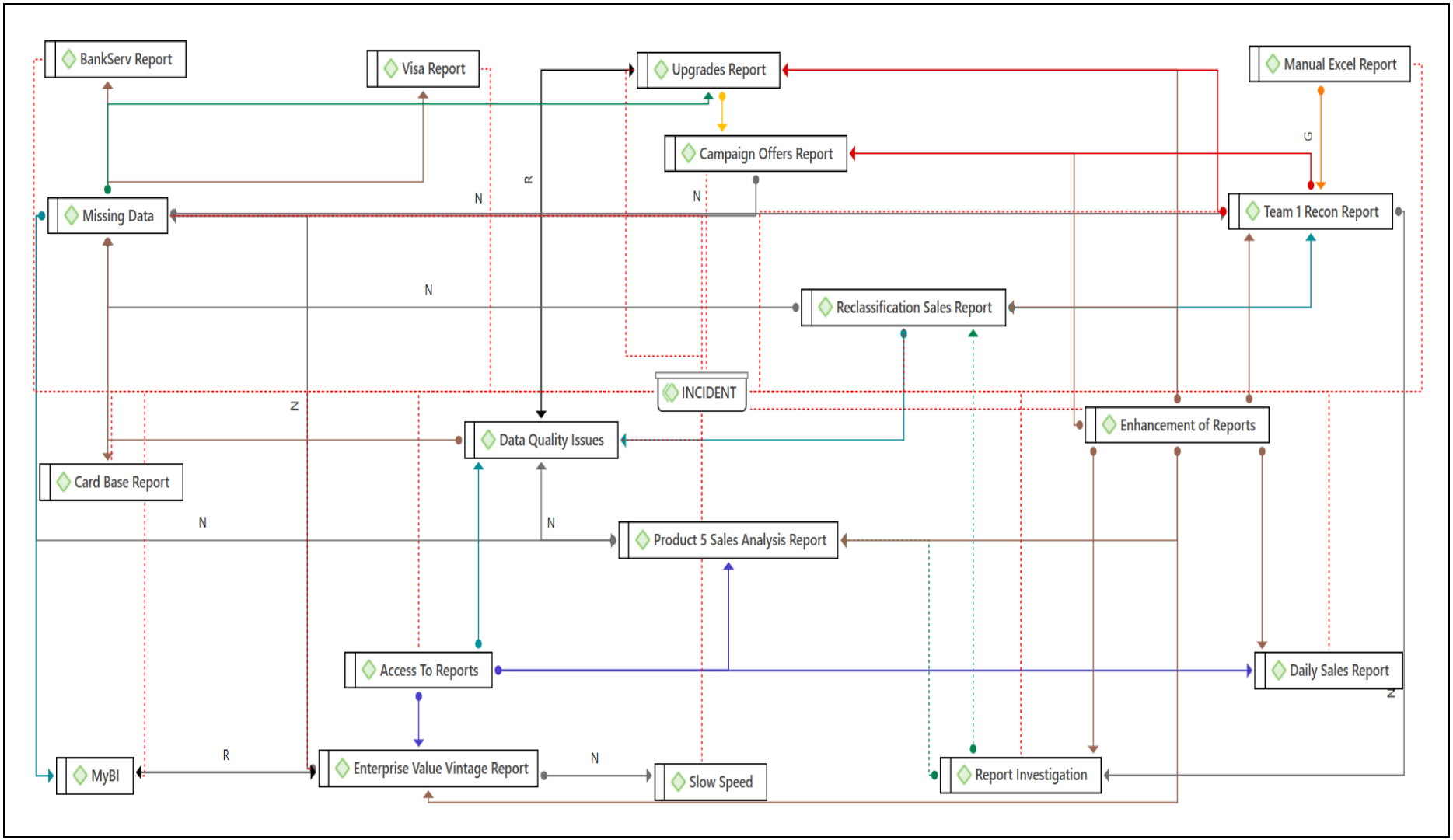

Figure 5.16: Network Diagram – Incident (Author's Compilation from *Atlas.ti*)

The BI report issues identified in this theme include *Missing Data*, *Data Quality Issues*, *Investigation of Reports*, *Slow Speed*, *Access to Reports*, *System Issues* and *Enhancement of The Reports*. These are discussed below:

- *Missing Data*, where some reports needed to be updated so that they reflected the latest data.
- *Data Quality, where some reports required* investigation between the front-end and back-end to identify the difference.
- *Reports Investigation*, where some reports reported on the same KPIs, but the total numbers reported were different and needed to be attended to.
- *Access to Reports*, where several reports were not being *accessible* on the report portal and the requestor wanted to understand the issue.
- *System Issue*, where a report was reported to be problematic, which was as a result of the system.
- *Slow Speed*, where some reports were reported for being slow in loading or responding. Further details were not captured on the CIL.

5.3.6.6. Data Extract

Table 5.9 shows the codes and the descriptions together with an indicator, indicating whether the code is a report or a BI issue.

Table 5.9: Data Extract Code and Code Descriptions

No	Code	Code description	BI report(R), BI issue (I)
1	Enterprise Value Sales & lifestyle sales report	A report that tracks the sales of the different products offered to customers.	R
2	Product 15 main account	Contains the main account holders for a particular product.	R
3	Product 9 secondary sales report	Data extract of the secondary sales of a particular product.	R
4	Sales Analysis Fast-track	A report that tracks sales.	R

No	Code	Code description	BI report(R), BI issue (I)
5	Delivery Tool Report	A report that tracks the delivery of customer products.	R
6	Opened Accounts	Accounts that are opened at a particular time. This code is used for both a report and a function.	R
7	Card Issuance	Contains the cards that were issued	R
8	Sales cube	A report that tracks the sales of accounts.	R
9	Call Centre performance report	A report that tracks the performance of the call centre.	R
10	Reclassification Report	A report that contains sales as well as open classifications.	R

According to Figure 5.17, 21 codes were identified for the data extract theme. Of the 21 codes identified, 14, namely, the *Product 3 Report*, *Reclassification Report*, *Reclassification Sales Report*, *Team 1 Recon Report*, *Call Centre Performance Report*, *Opened Accounts*, *Product 1 Daily File*, *Product 15 Main Account*, *Delivery Tool Report*, *Sales Cube*, *Card Issuance*, *Sales Analysis Fast Track*, *Account Fast-Track Report*, *Enterprise Value Sales & Lifestyle Sales Report* and *Product 9 Secondary Sales Report,* were related to the BI reports.

For this theme, a total of three BI report issues were identified on the CIL. These issues include the following:

- *Missing Data*, where the *Reclassification Report* and *Reclassification Sales Report* had *missing data* which resulted in the reports not being populated for certain days. The user wanted to understand who the person responsible for overseeing the monitoring of the report was, as it was not the first time this issue had occurred.
- *Enhancement of Reports*, the client asked for the report (*Enterprise Value Sales & Lifestyle Sales Report*) to be enhanced (enhancement of the report), as the client wanted to add emails to the report that had already been developed.

- *Report Investigation*, where the *Team 1 Recon Report* required investigation since differences were discovered in the total sales volume between this report and the *Reclassification Sales Report.*

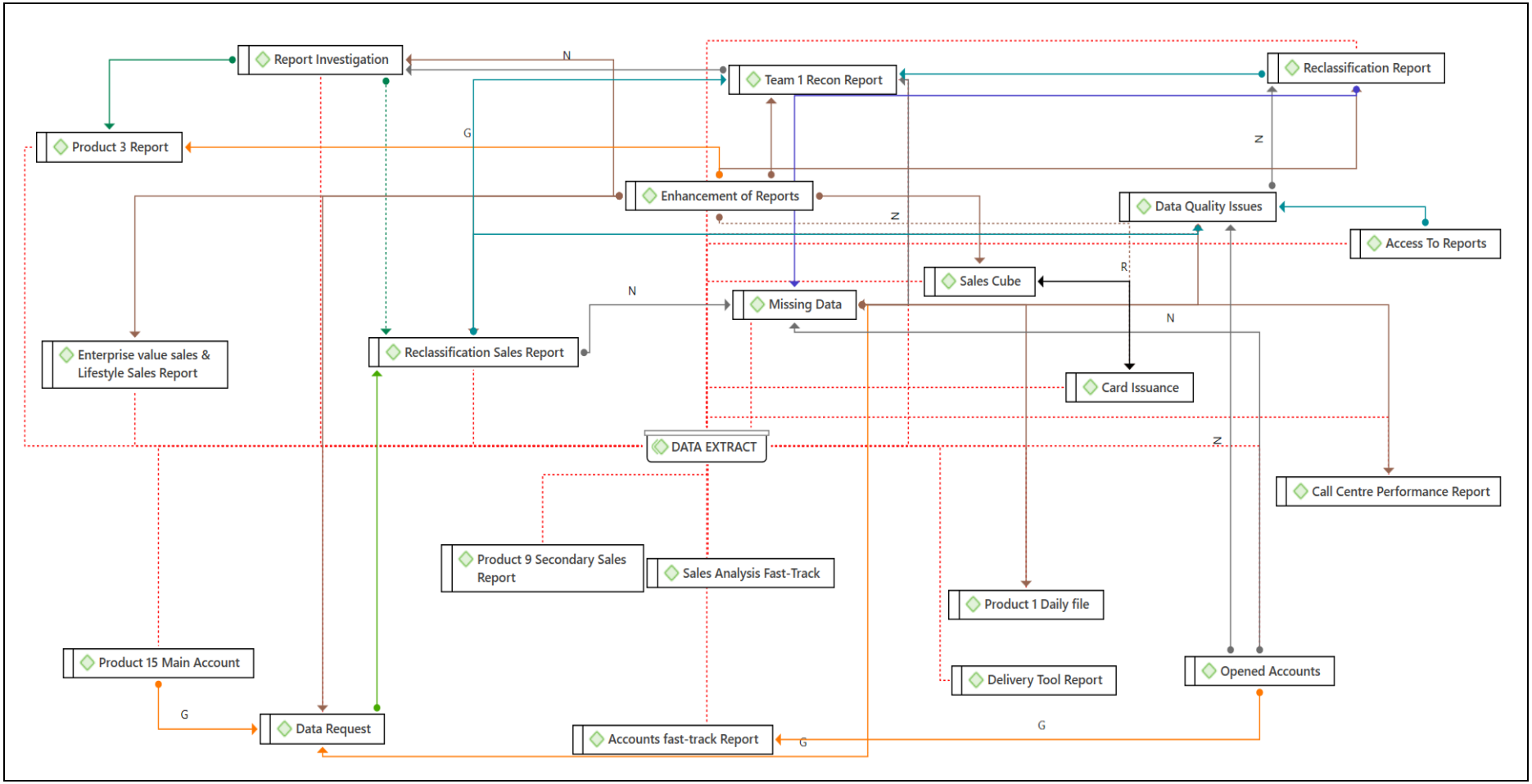

Figure 5.17: Network Diagram – Data Extract (Author's Compilation from *Atlas.ti*)

5.3.6.7. Small Project

Table 5.10 shows the codes and the descriptions together with an indicator, indicating whether the code is a report or a BI issue.

Table 5.10: Small Project Code and Code Descriptions

No	Code	Code description	BI report(R), BI issue (I)
1	Sales Daily War Room Report	A report that tracks sales.	R
2	Team Overview Report	A report that tracks employee performance.	R
3	Regional Manager Report	A report that tracks the regional managers of the different branches.	R
4	Product 16 Cross-Sell Campaign	This is a campaign for a particular product.	R

According to Figure 5.18, 13 codes were identified for the small project theme. Of the 13 codes, 11, namely, *Product 3 and 4 Report, Regional Manager Report, Third Party Report, Campaign Management Report, Team Overview Report, Sales Cube, Sales Report, Sales Daily War Room Report, Enterprise Value Vintage Report, Delivery Tool Report and Product 16 Cross-Sell Campaign,* related to the BI reports.

Three codes out of 11, namely, *Campaign Management Report, Team Overview Report and Product 16 Cross-Sell Campaign,* referred to new report development. *The Regional Manager Report* was requested for automation to avoid manual intervention. One request that was logged did not provide further clarification by the user; as a result, the request had to be closed. The remainder of the report codes were requested for enhancement (*Enhancement of Report*), for example the addition of a filter.

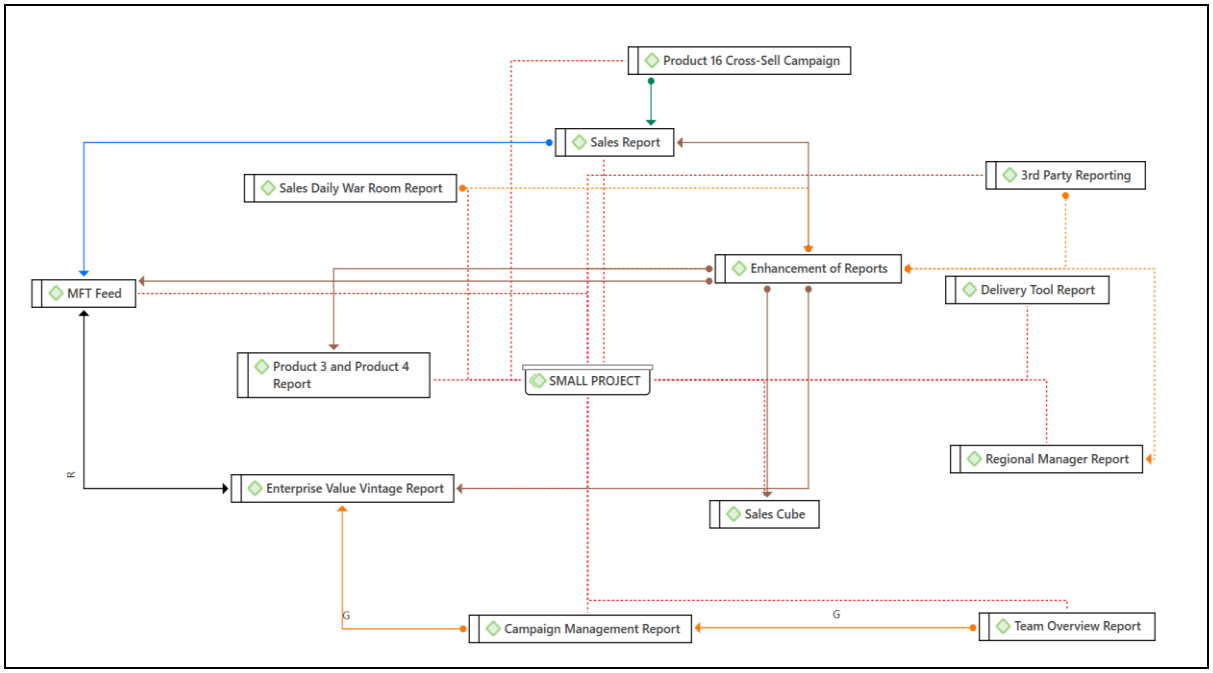

Figure 5.18: Network Diagram – Small Project (Author's Compilation from *Atlas.ti*)

5.3.6.8. Investigation

Table 5.11 shows the codes and the descriptions together with an indicator, indicating whether the code is a report or a BI issue.

Table 5.11: Investigation Code and Code Descriptions

No	Code	Code description	BI report(R), BI issue (I)
1	Reclassification Open Report	A report that tracks accounts opened on a daily basis	R
2	Product 9 Report	A report that tracks the performance of a product type	R
3	Sales and Sales Distribution Report	A report that tracks credit offers accepted by customers	R
4	Reclassification sales	A report that tracks active accounts on a daily basis	R
5	SIMS	A report used to track sales	R

No	Code	Code description	BI report(R), BI issue (I)
6	Sales Transactional Report	A report that tracks different KPIs	R
7	Transactional Cheque account	Contains data extracts for the transactional cheque account for a particular region	R
8	Full Decay Report	A report that tracks full decay of various products	R
9	Product 8 Missed sales report	A report that tracks the missed sales for a type of product	R
10	Product 7 Sales Report	A report that tracks a certain product sold to customers	R
11	Harambee_Dialstring Report	A report that tracks the performance of the Harambee dialstring	R
12	Harambee Tracking Report	A report that tracks Harambee sales	R
13	Daily Switch Report	A report that tracks daily switches	R
14	Team 4 v10 File	A file that tracks the sales of team 4	R

According to Figure 5.19, 35 codes were identified for the investigation theme. Of the 35 codes, 20, namely, *Upgrades Report*, *Product 5 Sales Analysis Report*, *Enterprise Value Vintage Report*, *Product 8 Missed Sales Report*, *Team 1 Recon Report*, *Sales Cube*, *Product 1 Daily File*, *Reclassification Report*, *Reclassification Sales Report*, *Reclassification Open Report*, *Sales Transactional Report*, *Sales Report*, *Full Decay Report*, *Daily Switch Report*, *Harambee_Dialstring Report*, *Harambee Report*, *Team 2 Monthly Pack Report*, *Team 4 V10 File*, *SIMS* and *Card Issuance*, are related to the BI reports, while one code is related to the report portal that was used to access these reports.

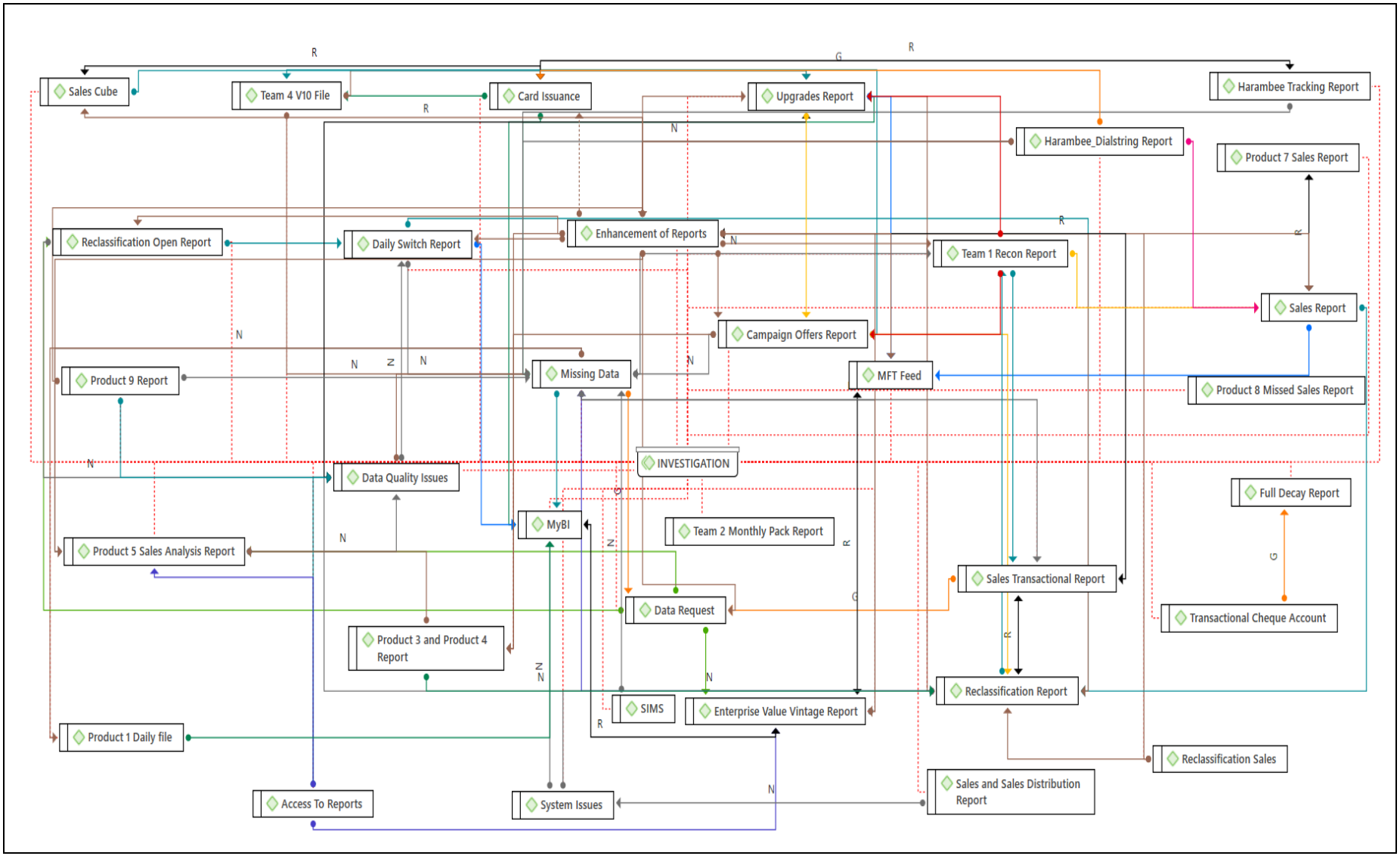

Figure 5.19: Network Diagram – Investigation (Author's Compilation from *Atlas.ti*)

The following BI reports contained issues that had to be investigated. These issues were as a result of the following:

- *Data Quality*, where the KPI volumes on one report differed on another.
- *Enhancement of the Reports*, where, in order for the enhancement to be done, an investigation had to be carried out first to ascertain whether what was required was doable.
- *Missing Data,* for a certain period. With regard to one report, the client wanted someone to help them understand it. This could be caused by factors such as the client being new or the report needing to be more self-explanatory, and required one of the people who had developed it to explain it so that the client would be able to use and understand it.
- *System Issues,* where the client could not extract any report from the portal, which affected their reporting to various stakeholders.
- *Access to reports,* where the users could not access reports, leaving them unable to carry out their duties.

5.3.6.9. Change Request

Table 5.12 shows the codes and the descriptions together with an indicator, indicating whether the code is a report or a BI issue.

Table 5.12: Change Request Code and Code Descriptions

No	Code	Code description	BI report(R), BI issue (I)
1	Daily KPI report	A report that tracks different KPIs	R
2	System constraints	Situations where the system uses a lot of resources which has a negative impact on performance	I
3	VSI report	Contains vendors' single interest report	R
4	Data extraction	Refers to occasions when the client requires data as an extract for reporting purposes	R
5	Sales Flat file	A daily file that tracks sales	R

No	Code	Code description	BI report(R), BI issue (I)
6	VIP Delivery file	A daily file that tracks the delivery file	R
7	Salary and Debit order Switch report	A report that tracks salary and debit order switching	R
8	On-boarding report	A report that tracks the onboarding of customers	R
9	Summary view report	A summary view of a report	R
10	Product 9 sales	Sales for a particular product	R

According to Figure 5.20, 41 codes were identified for the change request theme. Of the 41 codes, 30 codes, namely the *Sales Transactional Report*, *Upgrades Report*, *Product 5 Sales Analysis Report*, *Reclassification Report*, *Enterprise Value Vintage Report*, *Sales Quality Report*, *Campaign Offers Report*, *Regional Manager Report*, *VSI Report*, *Daily Switch Report*, *Product 3 Reports*, *Sales Cube*, *Sales Report*, *Onboarding Report*, *Card Issuance*, *Reclassification Sales Report*, *Reclassification Open Report*, *Daily KPI Report*, *Third Party Reporting, Product 9 Report*, *Harambee_Dialstring Report*, *Harambee Tracking Report*, *Summary View Report*, *Sales And Sales Distribution*, *Salary and Debit Order Switch Report*, *Team 1 Recon Report*, *Sales Flat File*, *Opportunity or Missed the Report*, *Product 9 Sales* and *VIP Delivery File* are related to the BI reports while the one is related to the report portal that was used to access these reports. The issues related to the BI banking reports include the following:

- *Enhancements of reports*, where some reports needed to be enhanced to include further requirements such as additional filters, columns, business rules, or data source change. The other reason for an enhancement was the client's dissatisfaction with a report and the requirement to rebuild it to enable its use by the team. Additionally, the client wanted the reports to align with KPIs that were similar to those the team was reporting on. This ensured that the reporting numbers were the same across the reports so as to avoid confusion or misalignment.

- *Missing data*, where some reports showed more or less data than others, which prompted the investigation and updating of the reports.
- *Data Quality,* where KPIs were inconsistent and null values were returned.
- System Issues, regarding the constraints or limitations in the system in deploying changes to production for a specific report.

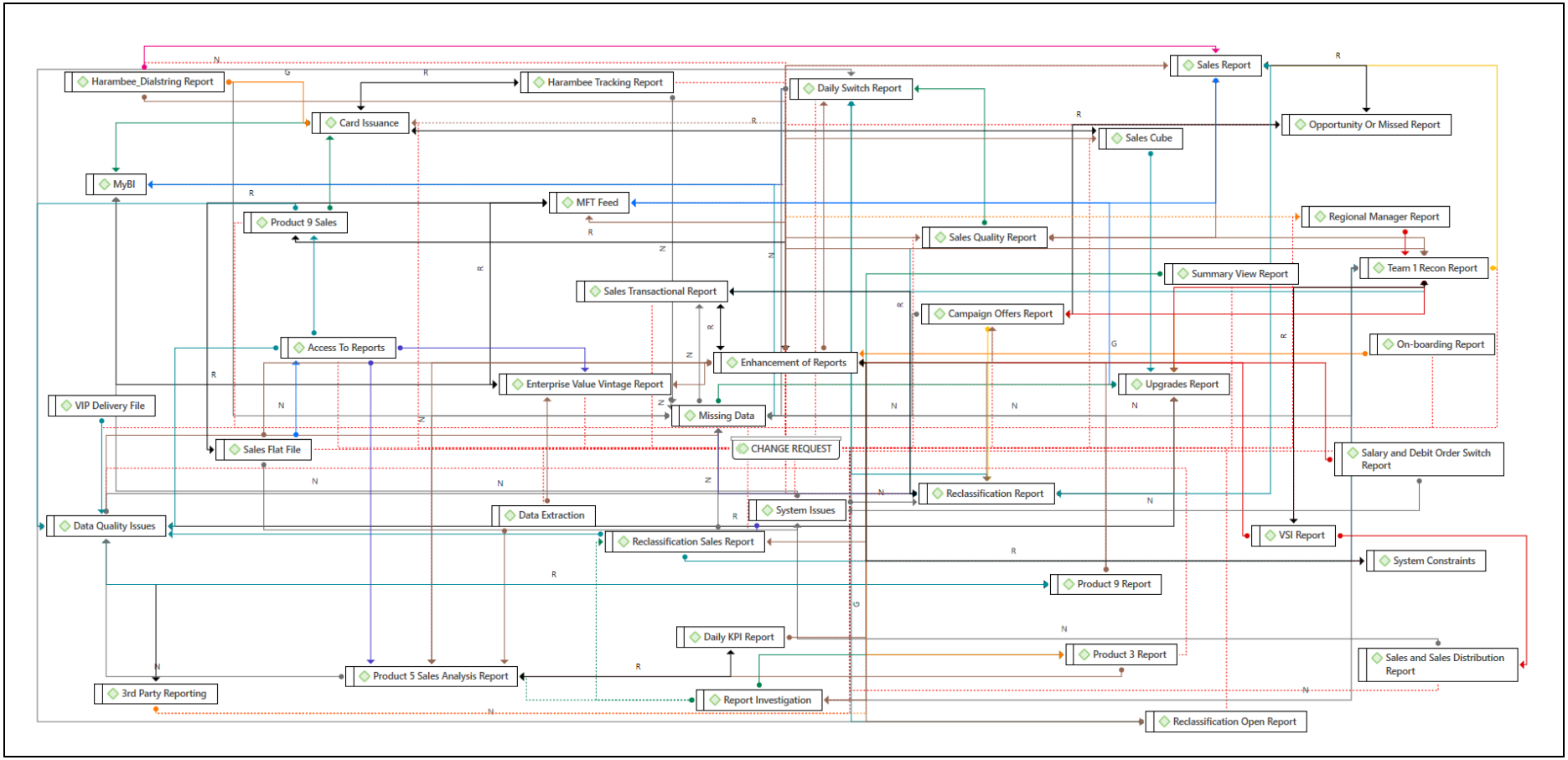

Figure 5.20: Network Diagram – Change Request (Author's Compilation from *Atlas.ti*)

5.3.7. Company Issues Log Data Extraction Findings Summary

Nine documents were created from the CIL and loaded into the *Atlas.ti* software for analysis. The nine documents each represented a theme name and a code group, with 75 codes that were used across the themes. In each of the themes it was noted that when a user logged a request, the requests were classified differently. Similarly, when logging a request, the data showed that users were not always allocated to the correct request type, for example some requests that required investigation were logged under the data extract request type.

Eight BI banking reports were identified across the different themes, namely, *Missing Data, System Issues, Data Quality Issues, Enhancement of Reports, Reports Investigation, Slow Speed, Access to Reports and Understanding of the Report.* Table 5.13 shows these BI banking report issues together with their descriptions.

Table 5.13: Refined BI banking Report Issues

No	BI Banking reports issues	BI banking report issues Description
1	Missing data	Reports not up to date
2	System issues	Reports not easy to use
3	Data quality issues	The data not consistent (e.g. some datasets include null values)
4	Enhancement of reports	Reports misaligned owing to the use of incorrect business rules
5	Reports investigation	Misalignment of reporting owing to the use of incorrect business rules Back-end and front-end misalignment
6	Slow speed	Report takes times to load, i.e. is slow in loading
7	Access to reports	Inaccessibility of reports
8	Understanding of the report	Clear understanding of the report

Figure 5.21 depicts the progression of the usability criteria from a set of LBUC to a set of empirically evaluated BIBRUC, which started with the NLR-based and the SLR-based usability criteria, which were combined to produce the LBUC. From thereon, the CIL data analysis aimed to produce BI banking report issues and their associated LBUC, which resulted in the BIBRUC. The reason for this was to identify which LBUC is associated with which BI banking report issues.

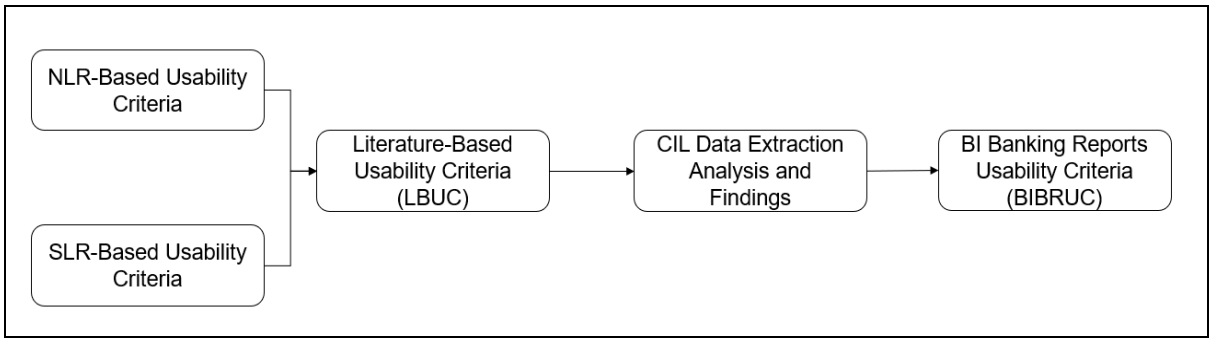

Figure 5.21: BIBRUC progression

This section addresses RSQ2: What are the usability issues of BI reports in the banking industry?

Table 5.14 contains the BI banking report issues as well as their associated LBUC. The LBUC in Table 5.14 are referred to as the BIBRUC, as a response to RSQ2. Based on the findings, the other LBUC are not presented in Table 5.14, which means that their relevance could not be confirmed based on the CIL data extraction.

Table 5.14: BI banking Report Issues and their Associated Usability Criteria

No	BI banking report issues descriptions	BIBRUC
1	Up-to-date reporting (reports are not up to date)	Task conformance Effectiveness Efficiency Consistency
2	Inconsistency in the data (e.g. null values)	Consistency
3	Misalignment of reporting	Task conformance Consistency

No	BI banking report issues descriptions	BIBRUC
4	Additional of requirements	Task conformance
5	Misalignment of reporting owing to incorrect business rules	Task conformance Consistency
6	Back-end and front-end misalignment	Task conformance Effectiveness Mapping
7	The report takes times to load	Responsiveness Efficiency Effectiveness Feedback
8	Inaccessibility of reports	Effectiveness Responsiveness
9	Clear understanding of the report	Task conformance Effectiveness
10	Reports are not usable	Effectiveness Customisation

Since *satisfaction* cannot be measured, this will be included as part of the BIBRUC regarding overall satisfaction with the BI baking reports.

Section 5.4 summarises the chapter.

5.4. Summary

In this chapter, the researcher performed survey data analysis to answer RSQ3 and CIL data extraction data analysis to answer RSQ2. The survey results showed that the participants were satisfied with the current state of the reports and based on the survey, no BI banking

report usability issues were identified. As a result, the statistical data analysis could not identify any usability issues that could be mapped to the usability criteria for evaluating the usability of such reports. Consequently, the study could not identify BIBRUC from a user's perspective (BIBRUCUP).

The researcher further analysed data gleaned from the CIL data extraction to answer RSQ2, 'What are the usability issues of business intelligence reports in the banking industry?' The results identified 10 BI banking report issues and mapped them to the LBUC, which in turn produced the BIBRUC.

The results pertaining to the survey and the CIL were contradictory, in that the survey results suggested that there are no BI banking usability issues, even though, based on the CIL data extraction pertaining to queries logged by users, BI banking usability issues do indeed exist.

From the 10 usability issues identified for BI banking reports, the researcher formulated the semi-structured interview questions to capture the data required to answer RSQ4 'What are the critical usability criteria that should be used to evaluate the business intelligence banking reports?' The next chapter presents the findings gleaned from the interviews.

CHAPTER 6 : INTERVIEW FINDINGS

6.1. Introduction

This section focuses on the analysis of the interview data using thematic analysis (TA), in order to triangulate the data with the previous results (BIBRUC [business intelligence banking reports usability criteria] and BIBRUCUP [business intelligence banking reports usability criteria from a user's perspective]), and so to confirm the critical business intelligence banking reports usability criteria from a user's perspective (CBIBRUCUP). This chapter is structured in the following way: section 6.2 presents the demographic variables, section 6.3 presents the CBIBRUCUP, while section 6.4 presents findings pertaining to user satisfaction. Section 6.5 presents the data triangulation for the study and the chapter concludes with section 6.6 which presents the chapter summary.

6.2. Demographic Variables

When conducting the interviews, the researcher began by asking the interviewees a number of questions aimed at obtaining demographic data. This was to ensure that the interviewee was older than 18 and that they were familiar with business intelligence (BI). This section contains the findings pertaining to the demographic information obtained. Section 6.2.1 contains the findings relating to age, while section 6.2.2 presents the findings on gender. Section 6.2.3 presents the findings pertaining to language, section 6.2.4 provides the findings for BI system user and section 6.2.5 presents findings on the BI user experience (UX). Lastly, section 6.2.6 presents findings relating to interviewees' experience in the area of BI.

6.2.1. Age

A total of 31 interviews were conducted. The interview questions contained a few demographic items to ensure that the interviewee qualified, was not underage and had experience in BI. The category, age, was divided into four groups. Accordingly, it was found that none of the interviewees were between the ages of 18 and 24 and only 3% were above the age of 45. The participants in the 25–34 age group comprised 48% of the sample, while the participants in the 35–44 age group also comprised 48%. This means that 96% of the respondents was between the ages of 25 and 44. Figure 6.1 shows sample distribution by age.

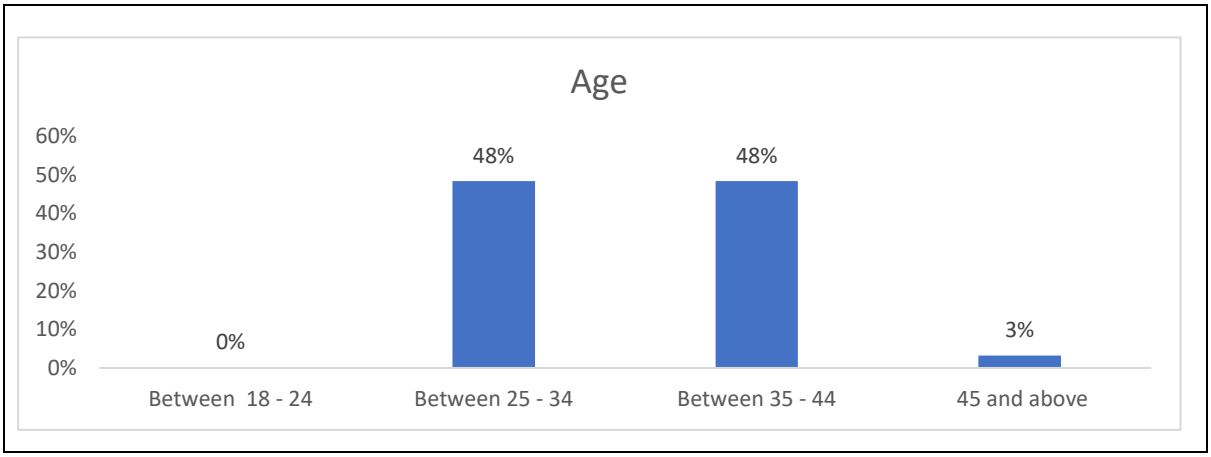

Figure 6.1: Sample Distribution by Age

6.2.2. Gender

15 males and 16 females participated in the study. This means that 52% of the participants were female while 48% of the participants were male.

6.2.3. Language

Figure 6.2 shows sample distribution by language. isiXhosa was the home language of most the participants (23%), followed by both isiZulu and Sepedi at 16% each. The Setswana and Xitsonga-speaking participants also had a similar percentage of 13% each, followed by Tshivenda and Sesotho with 6% each. Three per cent of the population was English speaking and 3% spoke Hindi. The latter is reflected as 'Other' in Figure 6.2 as it is not one of the official languages of SA. None of the participants had Afrikaans, siSwati or isiNdebele as a home language.

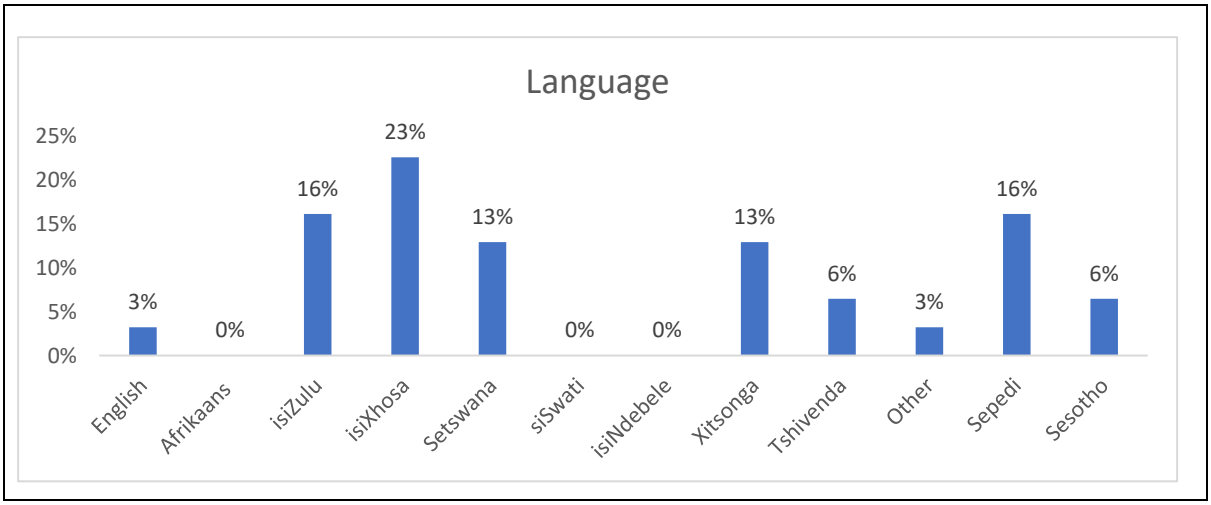

Figure 6.2: Sample Distribution by Language

6.2.4. Business Intelligence System User

The question related to use of the BI system was aimed at checking whether the participant had used the BI system before. If participants had no experience with BI, interviews would then discontinue. Therefore, all the participants in this research and in the interviews were BI system users (100%).

6.2.5. Business Intelligence User Experience

Most participants (71%) had been BI users for 48 or more months, followed by 12–24 months as BI users (13%). Both 0–3 months and 24–48 months as BI users were at 6% and, lastly, 3–12 months as a BI user comprised 3%. Figure 6.3 shows the participants' experience as BI users (distribution by BI user experience).

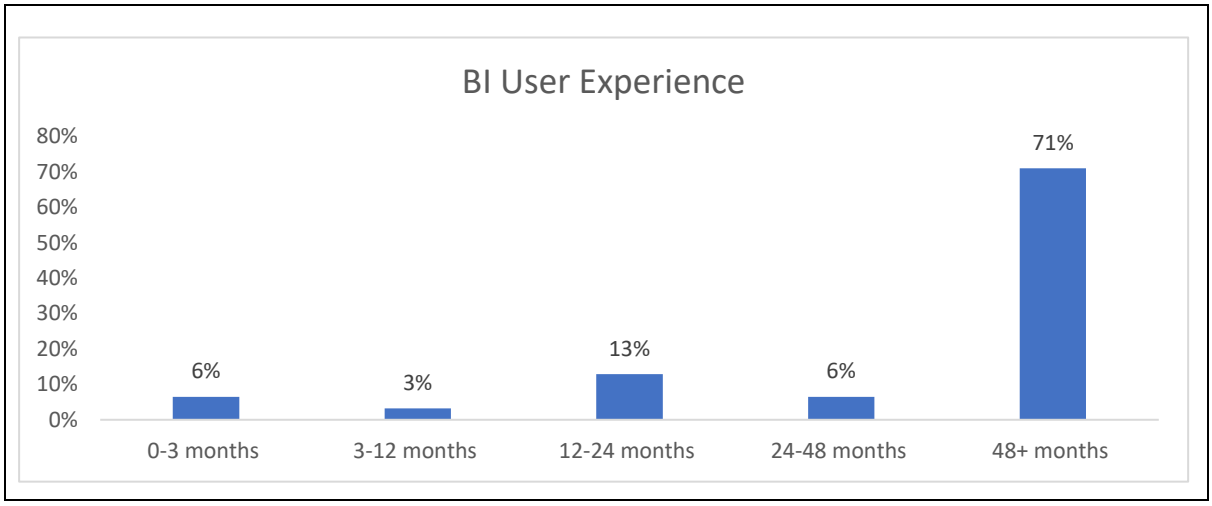

Figure 6.3: Sample Distribution by BI User Experience

6.2.6. Experience in Business Intelligence Areas

The participants were asked to choose from five BI areas to indicate the area in which they had experience. For this question participants could select more than one option because their experiences might be varied. As indicated in Chapter 2 section 2.6, online analytical processing (OLAP) cubes, dashboards, reports, catalogues and data mining were provided as reports for the purposes of this study, as stakeholders use these areas interchangeably. The analysis found that 38% of the participants had experience in the reports and dashboard BI areas, 26% had experience in all the BI areas, 10% had experience in data mining, reports and dashboard BI areas, 10% had experience with OLAP cubes, reports and dashboards, and 6% had experience with dashboards only. Finally, just 3% had experience in OLAP cubes, data mining, reports and dashboards; OLAP cubes, catalogues, reports and dashboards; data

mining and dashboards; catalogues, reports and dashboards; as well as OLAP cubes and dashboard BI areas. Figure 6.4 illustrates the participants' experience in BI areas.

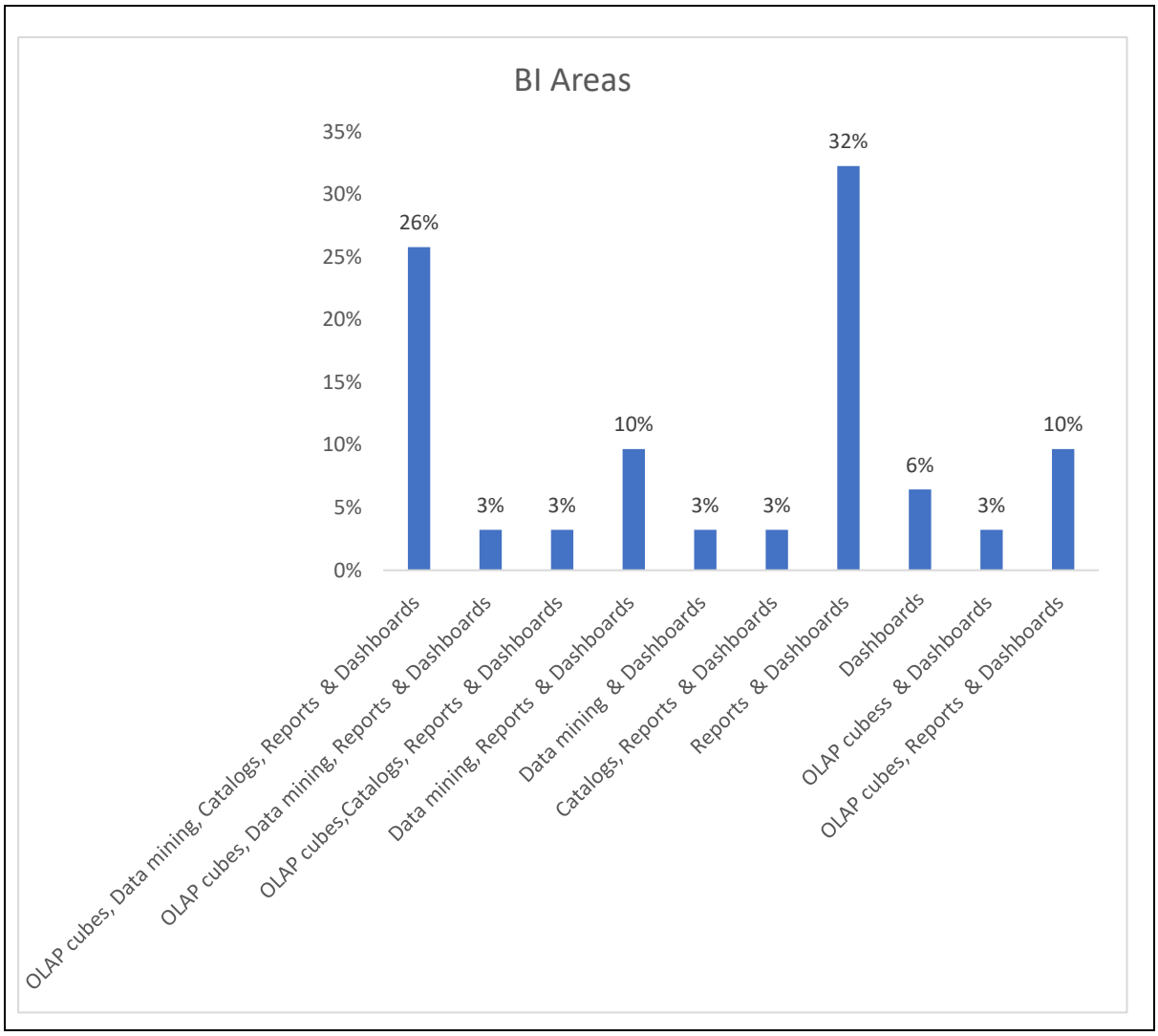

Figure 6.4: Experience in BI Areas

Section 6.3 presents the CBIBRUCUP findings.

6.3. Critical Business Intelligence Banking Report Usability Criteria from a User's Perspective

This section focuses on the main interview questions, the responses to which were analysed using TA following the six-phase TA process advocated by Braun and Clarke (2006) and using *Atlas.ti* (see section 4.4.3). The following sections (6.3.1–6.3.6) provide the details of the analysis.

6.3.1. Phase 1: Becoming Familiar with the Data

The researcher formulated the questions to be used during the semi-structured interviews. These questions covered the 10 BI report issues, as per the findings in Table 5.14 in Chapter 5 section 5.3 and were intended to investigate and identify the critical usability criteria that should be used to evaluate BI banking reports.

The interviews were conducted with 31 participants from the business unit of the bank, subsequently producing 31 documents, each containing the interview questions together with the interviewees' responses. The 31 documents were uploaded to the *Atlas.ti* software for TA, following the same process as indicated in Chapter 5 section 5.3.1.

Creation of Project in Atlas.ti

To analyse the data using *Atlas.ti*, the researcher created a new project and named it *Pheladi Interview Project*, which was used to store all the project files for this study. This project was linked to a container housing the 31 MS Word documents, which were created using the participants' interview transcripts prior to uploading them to *Atlas.ti*. Figure 6.5 provides a screenshot of *Atlas.ti* showing the number of documents uploaded, the initial codes created and the code groups.

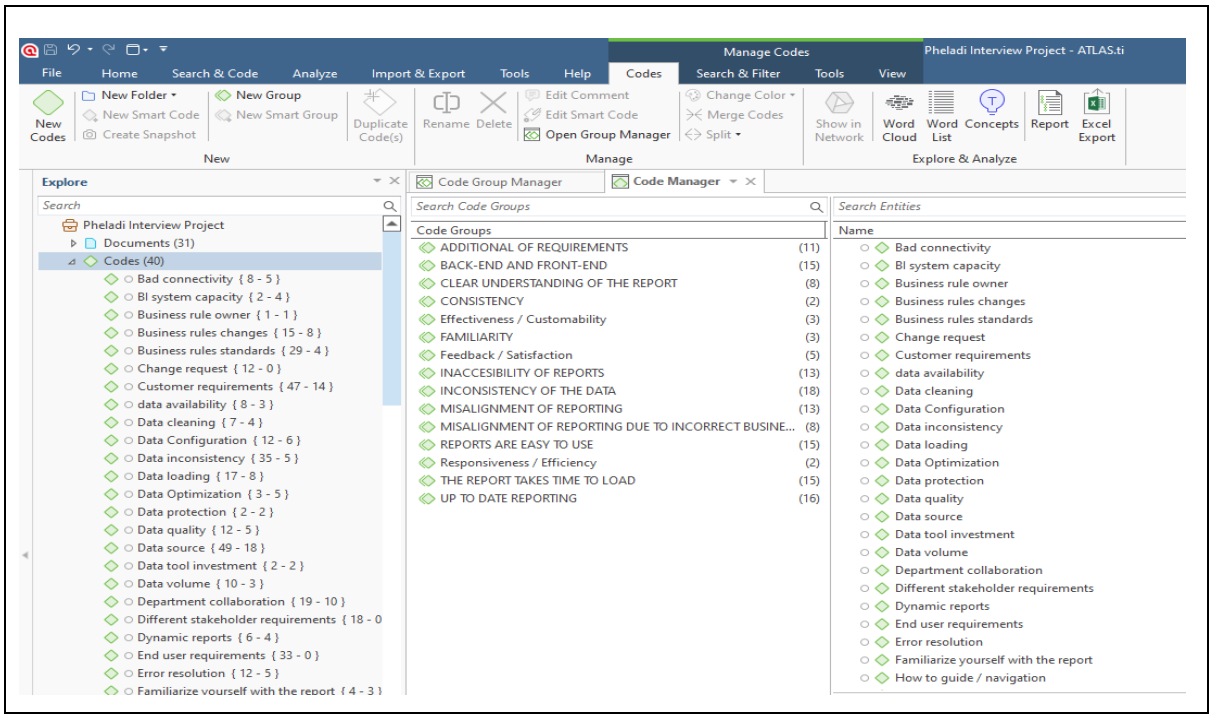

Figure 6.5: Sample *Atlas.ti* screen

Section 6.3.2 explains the generation of the initial codes in Phase 2.

6.3.2. Phase 2: Generating Initial Codes

There are two major approaches to coding, as discussed in Chapter 4 (section 4.4.3). The approach used for this study was an inductive approach, which entailed the researcher transcribing the interview data, while staying loyal to the content the interviewees had provided. The researcher did not specifically draw on prior knowledge or known concepts to influence the outcome of code creation.

The codes for this study were created in line with the contents of the interview transcriptions. Owing to the confidentiality of the data, details that would have given away the identity of the bank were anonymised using aliases. For example, suppose the interviewee used the name of the business unit. In that case, the researcher would alias the business unit name as 'team 1' and then group them to maintain anonymity.

As stated in Chapter 4 (section 4.4.3), a manual coding process was used for this study. Codes were created by viewing each transcript and going through the content, ultimately producing 50 codes.

After creating the initial codes, the researcher checked whether they had been added to the code list by clicking on the codes on the navigator panel in *Atlas.ti* to view them (see Figure 6.6 which depicts a subset of the codes). This was done to ensure the accuracy of the initial codes and that no codes had accidentally not been captured. The codes were also added to the Excel file for additional cross-referencing.

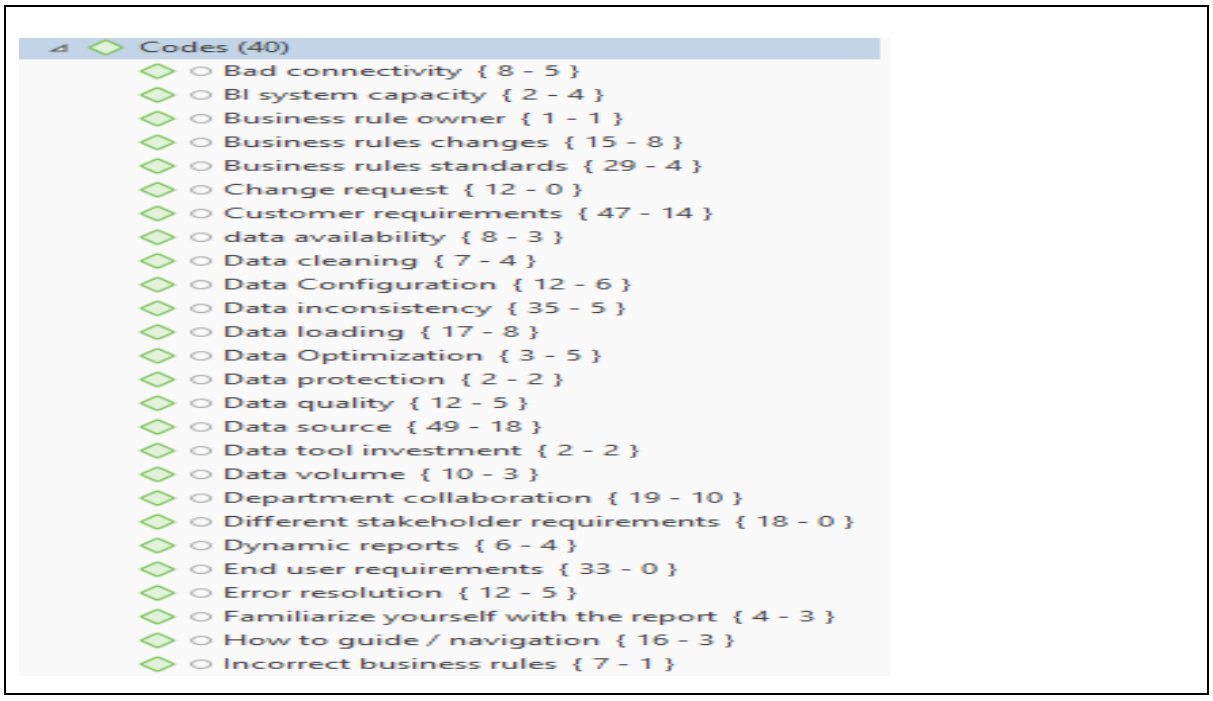

Figure 6.6: List of initial codes extracted from *Atlas.ti*

Section 6.3.3 describes Phase 3 in which the search for themes took place.

6.3.3. Phase 3: Searching for Themes

To draw themes from the interview data, the researcher used a deductive approach because the themes were formulated in line with the BI banking usability issues identified during the analysis of the CIL data.

An inductive approach was used for this part of the study. Accordingly, the researcher transcribed the interviews, staying loyal to their content. Subsequently, 10 code groups and 10 networks were identified from the 31 documents. The captured codes were allocated to the relevant code groups to create network diagrams. The names for both the network diagrams and code groups are similar to the names allocated to the documents. This was done to ensure the consistency of the network diagrams. For example, for the code group 'The report takes time to load' a network exists with the same name (see Figure 6.7).

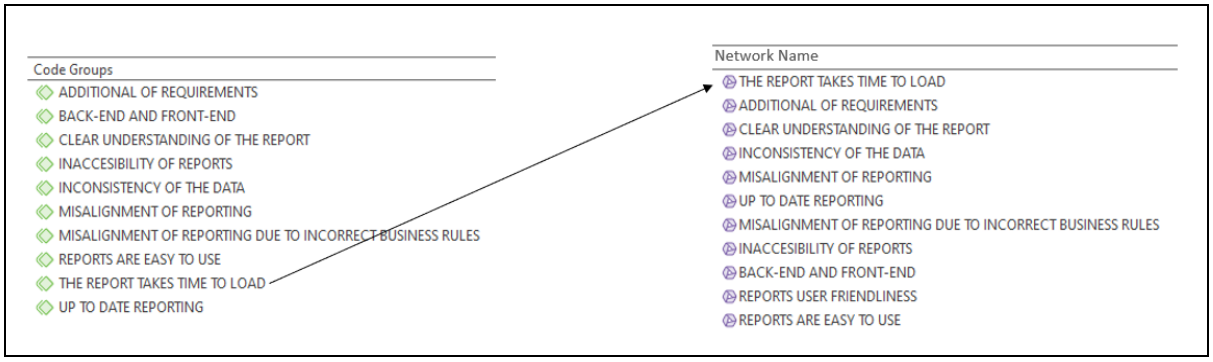

Figure 6.7: Interview Data Code group with respective network name

Section 6.3.4 discusses Phase 4 in which the themes were reviewed.

6.3.4. Phase 4: Reviewing Themes

In this phase the researcher reviewed both the allocated codes and the code groups, also revisiting the codes allocated to each code group and ensuring that the allocation was correct. Of the 50 codes created initially (see section 6.3.2), 35 were retained.

Section 6.3.5 discussed Phase 5 in which the themes were defined and named.

6.3.5. Phase 5: Defining and Naming Themes

In this phase, the thinking behind the code groups was reconsidered based on the data capturing and familiarisation in Phase 3 (section 5.3.3). Subsequently, the code groups remained the same as per Phase 4. Figure 6.8 depicts a network diagram in *Atlas.ti*, showing the themes gleaned from interview data: *Inconsistency of the Data*, *Additional of Requirements, the Report Takes Time to Load*, *Inaccessibility of Reports*, *Back-End and*

Front-End, Clear Understanding of the Report, *Reports are not Easy to Use*, *Up to Date Reporting* and *Misalignment of Reporting Due to Incorrect Business Rules.*

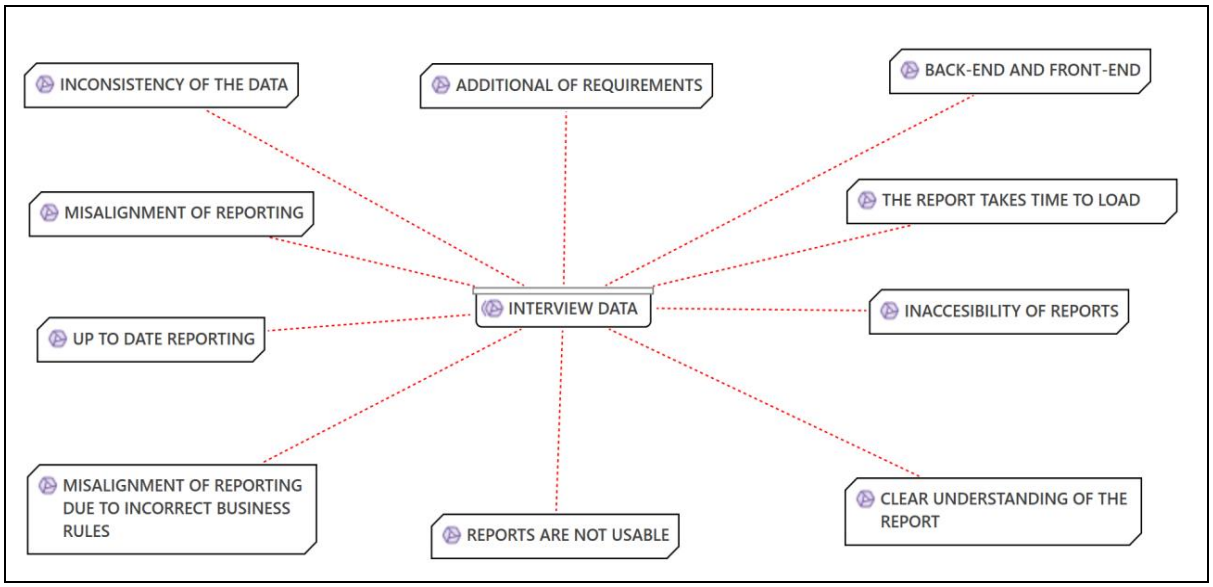

Figure 6.8: Network Diagram Showing the Themes for CIL Data

Section 6.3.6 presents the analysis of the report.

6.3.6. Phase 6: Producing the Report

For this phase, the code groups were used to create the network views and diagrams for each theme. The code relationships used were part of the standard relationships found in the *Atlas.ti* tool, for example ‘associated with’ and ‘is part of’. The researcher captured only two new relationships, namely, affects and provides, by dragging the relationship link between the respective codes, clicking on the new relationship and typing the relationship name. This section contains the network diagrams for each theme.

Network views for each theme were generated by *Atlas.ti*. As indicated in Chapter 5 section 5.3.6, to differentiate between the theme name and a code, themes are depicted in uppercase letters in all the network diagrams and codes have initial caps. Figure 6.9 depicts the legend used for the code relationships for all the networks. Please note that owing to the limitations of *Atlas.ti*, only a few colours were available for the relationships, resulting in the same colour being used twice, although the style of the relationship line is different. Another limitation relates to the relationship name; only three options were available, namely, full relationship name which clusters the network diagram, the symbol and the short name. For the network diagrams in this study, we chose the short name, for example ‘A’, which is short for ‘Contradicts’. Because of this limitation only a few selected short names of relationships are shown in all the network diagrams (see Figures 6.10–6.19). The relationship with the short

name is depicted because these relationships were inherited from *Atlas.ti*. As a result, there will be instances in the network diagram where the short name is shown for some relationships while it is not shown in other instances.

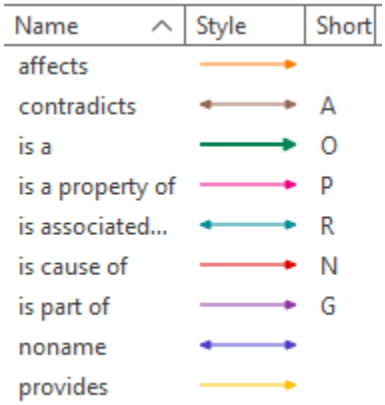

Figure 6.9: Legend Used for the Code Relationships for All the Networks

6.3.6.1. The Report Takes Time to Load

a) Codes and the Network Diagram

This theme refers to situations where reports load so slowly that it becomes an issue for the users, who then inform the BI team in order to have the issue resolved. Table 6.1 shows the codes and their descriptions identified for this theme. Figure 6.10 depicts the network diagram with 15 codes.

Table 6.1: The Report Takes Time to Load Code and Code Descriptions

No	Code	Description
1	Bad connectivity	This relates to the problem with the way the connection was set up.
2	BI system capacity	This relates to the maximum number of BI systems used at any one time.
3	Customer requirements	These are requirements requested by the stakeholder.
4	Data cleaning	This is the process used to cleanse the data.
5	Data configuration	This relates to the setup of the tools in the environment.
6	Data loading	This refers to loading the data into the tables or data sources for consumption

No	Code	Description
7	Data optimization	This refers to queries in the system being optimised so that they do not remain in the system longer than necessary.
8	Data source	This term is often used interchangeably with a table and relates to where the data is stored.
9	Data volume	This relates to the amount of data that is stored, such as in a data source, or required for reporting.
10	Error resolution	This refers to an error that may have been encountered in the report, for example during data loading.
11	Loading time	This refers to the time it takes to load the data from the source.
12	Monitoring system	This is used to monitor extract, transform and load (ETL) jobs and ensures that every job runs successfully and those that fail are remediated.
13	Report Availability	This is when the report is made ready for consumption.
14	Report testing	This refers to stakeholders' ability to test the report.
15	System performance	The ability for the system to be efficient enough to process any queries

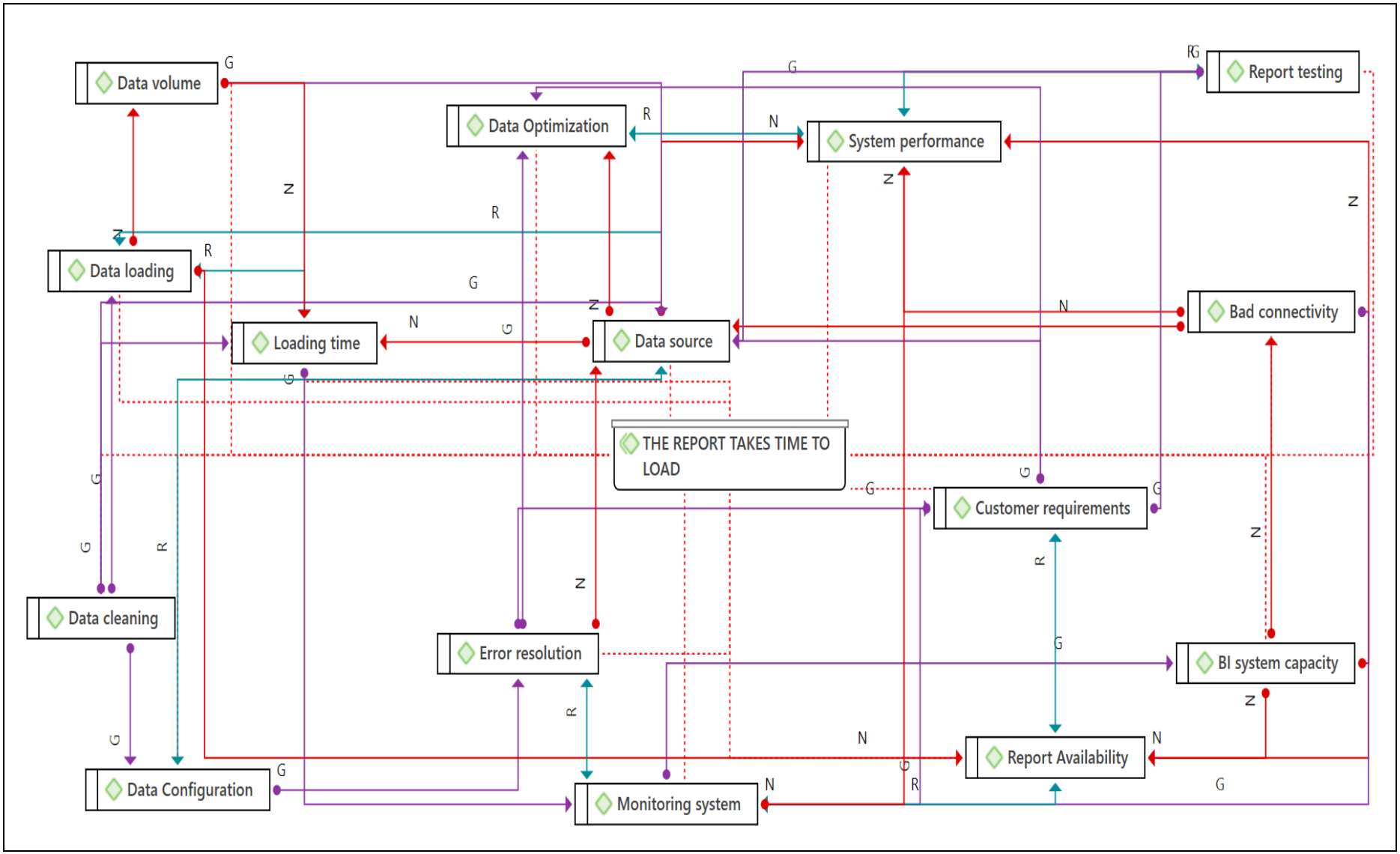

Figure 6.10: Network Diagram – The Report Takes Time to Load (Author's compilation from *Atlas.ti*)

b) Excerpts from the Interviews

The BI banking report issues and verbatim extracts from the interview data provide a context for the feedback obtained from the interviews. The extracts refer to the interviewees' verbatim responses to the interview questions while relating their encounters with the BI banking reports. As may be seen from the diagram in Figure 6.9, the issue relates to the fact that the BI report takes time to load. Each code is accompanied by a number of verbatim quotes that relate to the specific BI banking report issue, with each quote being given the page number (represented by p) in the document uploaded to *Atlas.ti*.

Error Resolution

> Excerpt 29:6 p2, 'Well, for this one, I needed to optimise the query and break it down into subsections. '
>
> Excerpt 23:4, p2, 'So, the problem was the scripting, so I didn't put indexing in my SQL scripting, so that's what caused the report to hang. So, once I put the indexes so that's how I managed to resolve that issue. It was just a matter of putting the indexes in my scripting.'
>
> Excerpt 30:4, p2, 'To resolve it we optimise the query because it was mostly the select all and the person that developed that the report used the select all and some other fields are not being used. Then we must optimise and select the columns that we needed there and then the report managed to work quicker.'

Monitoring System

> Excerpt 20:5, p2, '… if it's even a Saturday or Sunday, 24 hours, maybe even every hour, just check the report if it's, so that monitoring system to quickly identify these issues.'
>
> Excerpt 26:16, p4, 'So, there we had to change like the scheduling. So, the scheduling was not set properly and then the other way also is that it was pointing to the wrong tables that way pointing on Dev. So, the environment was not changed to point to production.'

Data Volume

> Excerpt 31:24, p2, 'It's mainly the volumes of data that you are working on.'
>
> Excerpt 25:27, p2, 'Have experienced this on numerous occasions. Some of which was due to large datasets that the report was coming through.'

Excerpt 14:31, p2, ‘Sometimes you know the underlying data set is very huge.’

Excerpt 22:29, p2, ‘I think the issue was that the data size. So maybe we should have archived the data that was not needed and just leave the one that we need for the reporting.’

Excerpt 5:3, p2, ‘So, it's not easy to be fixed, because sometimes you're going to have a lot of big dashboards with all the data in the background which is loaded that takes time.’

Loading Time

Excerpt 14:4, p2, ‘Sometimes you know the underlying data set is very huge. Then and both the filters are not, you know properly applied. Then sometimes it takes a lot of time to refresh the report or load the report.’

Excerpt 27:3, p2, ‘like it takes longer for reports to load. So, it's like a frequent thing like month ends, Fridays as well.’

Excerpt 5:2, p2, ‘Has frequent like when you open, mostly when you open the dashboard Takes time depend also how big it is.’

Data Loading

Excerpt 25:4, p2, ‘Resolution of that was reducing the amount of data in order to load the dashboard.’

Data Configuration

Excerpt 8:3, p2, ‘so you find that somebody creates a view on the server on the SQL Server, but then the report is not pointing to the correct view. So, what needed to be done there to make sure that the front end is pointing to the correct source.’

Excerpt 21:38, p5–6, ‘So, underlying data will be talking to the source of your source of data and then if it's an environment it's the environment from your side where you are running your report. It's not configured correctly, so it's just a matter of checking if the configurations are properly done, or it can be from the source where you're getting your data that environment from that might also be having some issues.’

Data Cleaning

Excerpt 9:17, p3, ‘Data clean-up from their source’

Excerpt 6:3, p2, ‘I believe removing historic data. The data that is no longer being used and to make sure that data is cleaned up like if there are certain records which are no longer relevant to the bank as a whole …’

Report Availability

Excerpt 16:5, p2, ‘You log in around seven. There was no report and there would have to rerun the report and do some analytics. I'm assuming on their side only for you to get the report later in the day.’

Excerpt 29:24, p5, ‘Ensuring that the reports are updated and constantly checking if they are being used.’

BI System Capacity

Excerpt 4:2, p2, ‘I would like to think that maybe the environment in which these reports are done the capacity is not maybe It's not maximised enough to handle a certain number of users.’

Report Testing

Excerpt 25:28, p5, ‘I think sufficient testing or more detailed testing between the source and target underlying tables to ensure that the report view is amended correctly.’

Excerpt 11:34, p6, ‘Proper testing, proper testing and a report can’t go live without making sure that the numbers in the back end reflect the numbers in the front end.’

Excerpt 5:32, p4, ‘If it was the beginning of the creation of the dashboard, but that can happen because you need to compare with other system. But once it's in prod, we know that the what the testing and the integrity have already been done, so it's going to be like once.’

System Performance

Excerpt 11:4, p2, ‘Better or efficient queries and make sure that all of Platforms or systems and databases are always up and running and monitor if things go down.’

Excerpt 14:5, p2,’ I mean, it depends on two things. One is you know like if the underlying data set which the report is pointing. If that is very huge, in terms of all volumes and it takes time to, you know, do their aggregations and then so it on the report and the other root cause for that …’

Excerpt 26:3, p,' So, there is performance tuning and then also aggregating of your data and that too at lower grain of your reporting ...'

Bad Connectivity

Excerpt 13:8, p3 "Maybe there was a connection issue between the source, so the data was not refreshed properly."

Excerpt 5:17, p4, 'It depends if there was an issue of the connection may be in at the back end or something that stopped the refreshing of a dashboard.'

Excerpt 20:17, p7, '… If it's network issues, then you know that instead of using a mobile router, you must have a maybe fibre connection.)

Excerpt 21:5, p2, 'One issue could be the fact that maybe the system was down like meaning connectivity …'

Data Optimization

Excerpt 32:22, p2, 'What needs to be done, I think on the background, I don't know if Power BI can optimise that bit quicker to then get the results out faster …'

Excerpt 4:33, p5, 'Alternatively, then you try to have optimisation on your source systems or database where it's pulling from. Trying to implement indexes. '

Excerpt 4:5, p2, '… maybe in terms of the development of the report where it's pulling data from needs to be optimised.'

Data Source

Excerpt 17:4, p2, 'Well, in most cases I would say making sure that your source data is correct or rather ready make sure that your database is up.'

Excerpt 1:5, p2, 'First thing from the data source perspective, you need to only bring the fields of the records that you want to show instead of having to get everything from the data sources, right.'

Excerpt 3:23, p6, 'The number of issues with this one, right, one would be data is probably missing. So, data from source has not been populated and it's missing and therefore the report that is using that source cannot update the report.'

Customer Requirements

> Excerpt 31:7, p3, ‘So, for me, it's an issue but not an issue. You know what I mean, there is going to be constant change in business requirement that we cannot run away from.’
>
> Excerpt 17:22, p6, ‘look, when it comes to the report builders, you can't really control that because those are the business rules that were given by business as a techie, you wouldn't necessarily know exactly what the requirements are.’
>
> Excerpt 16:8, p3, ‘When a system is implemented before a report, or a dashboard is built for the same system. It needs to be built in its entirety, meaning in its full scope, so that then there are no changes coming in because enhancements come in as due to either scope creep or something that was missed in the initial scope and therefore must be accommodated every now and again.’
>
> Excerpt 5:28, p6, ‘Just to understand the requirement properly, because the interpretation of the requirements and trends that makes that misalignment.’

c) Relating BI Banking Report Issues (Codes) to BIBRUC and BIBRUCUP

Based on the codes in this theme (network diagram and the associated excerpts), the BI banking reports issue (*the report takes time to load*) extracted from the CIL data refers to an issue that resonated with the interviewees, with multiple BIBRUC and BIBRUCUP being observed regarding this issue. The codes related to BIBRUC and BIBRUCUP (see Table 6.1) will now be discussed.

- The usability criterion that resonates with the ‘*Error Resolution*’ and ‘*Data Optimization*’ codes is *responsiveness*.
    - *Responsiveness* refers to users’ need to optimise their queries, which took time to load when trying to solve this issue. The interviewees also mentioned that this is a recurring issue. Optimising the BI banking reports means enhancing what already exists with additional functionality to increase the speed at which the system performs.
- The usability criteria that resonate with the ‘*Data Volume’* code are *responsiveness and efficiency*.
    - *Responsiveness* because, as interviewees mentioned, this issue tends to happen on Mondays and at month-end, at which time there are many tasks that

have to be carried out and thus many reports that have to be refreshed and updated.
    - *Efficiency* because when the data volume is high, it results in the reports being slow to load and affects the user's productivity.
- The usability criteria that resonate with the codes '*Data Loading'* and '*Loading Time*' are *responsiveness and efficiency*.
    - *Responsiveness* because sometimes when there are connectivity issues the speed at which the data has to be loaded slows down.
    - *Efficiency* because if reports take time to load, users will not be able to complete their tasks timeously.
- The usability criteria that resonate with the '*Monitoring System*' code are *recoverability and feedback*.
    - *Recoverability* because the user can identify the system issues during run time in relation to where the tables are pointing and then make changes to fix the issue. The system also assists the team in monitoring reports and data in order to take corrective action should an issue arise.
    - *Feedback* because the system provides feedback to users when performing their duties and on whether the report has been updated or is in the process of being updated, for example.
- The usability criteria that resonate with the '*Data Configuration'* code are *responsiveness* and *recoverability*.
    - *Responsiveness* because large volumes of data affect performance and result in reports taking time to load.
    - *Recoverability* because the team member identified the issue related to the connection of where the tables were pointing and made changes to fix the issue.
- The usability criteria that resonate with the '*System Performance'* and '*Bad Connectivity*' codes are *responsiveness* and *effectiveness*.
    - *Responsiveness* because large volumes of data and poor connectivity affect performance and raise the issue that the report takes time to load.
    - *Effectiveness* because lack of responsiveness of reports when a team or stakeholder is performing a task affects the way they perform their day-to-day activities.
- The usability criterion that resonates with '*Report Testing'* code is *effectiveness*.

    - *Effectiveness* because when users do not test reports properly to ensure that they are beneficial and as intended, issues arise when attempting to start using the report.
- The usability criteria that resonate with the '*Report Availability'* code are effectiveness and *consistency*.
    - *Effectiveness* because if the report is unavailable, users will not be able to carry out their tasks as planned.
    - *Consistency* because if the report is unavailable when needed by users, they will not be able to do their work.
- The usability criterion that resonates with the '*BI System Capacity'* code is *multi-threading*.
    - *Multi-threading* because, as indicated by a verbatim quote from the user, the BI system is not set up in a way that can support multiple users performing tasks at the same time or users attending to more than one task at a time.
- The usability criterion that resonates with the '*Data Cleaning'* code is *mapping*.
    - *Mapping* because cleaning the data means that users remove historical data that is no longer required, which helps improve the performance of the report system.
- The usability criterion that resonates with the '*Customer Requirements'* code is *effectiveness*.
    - *Effectiveness* because the developer needs to understand customer requirements when designing and producing the intended report in the way the user anticipated.
- The usability criterion that resonates with the '*Data Source'* code is *mapping.*
    - *Mapping* because if the report and the data source where the report is supposed to be read are not populated, users will not be able to perform their tasks.

Table 6.2 shows the codes and their respective BIBRUC and BIBRUCUP, as discussed.

Table 6.2: The Report Takes Time to Load and Associated BIBRUC and BIBRUCUP

No	**Code**	**Refined Usability criteria**
1	Bad connectivity	Responsiveness & effectiveness
2	BI system capacity	Multi-threading

No	Code	Refined Usability criteria
3	Data cleaning	Mapping
4	Data configuration	Responsiveness & recoverability
5	Data loading	Responsiveness & efficiency
6	Data optimization	Responsiveness
7	Data volume	Responsiveness & efficiency
8	Error resolution	Responsiveness
9	Loading time	Responsiveness & efficiency
10	Monitoring system	Recoverability & feedback
11	Report availability	Effectiveness & consistency
12	Report testing	Effectiveness
13	System performance	Responsiveness & effectiveness
14	Data source	Mapping
15	Customer requirements	Effectiveness

6.3.6.2. Addition of Requirements

a) Codes and the Network Diagram

This theme refers to situations where users require enhancements to existing reports, such as adding more features and/or removing others. Table 6.3 shows the codes and their descriptions identified for this theme. This table includes only those codes and descriptions that were not previously listed in Table 6.1. The same approach is taken to the remainder of the tables in the subsequent sections in order to avoid repetition. However, all the codes and their descriptions are included in Appendix G. Figure 6.11 depicts the network diagram with the 11 codes identified (this includes all the codes irrespective of whether they were included in Figure 6.9 or not, to give a true reflection of the network diagram); this will also be applied in all the network diagrams in this chapter. This figure takes the form of a network diagram with the names of codes, relationships and theme.

Table 6.3: Addition of Requirements Code and Code Descriptions

No	Code	Description
1	Business rules changes	Business rules are predefined conditions that aim to standardise organisational workflow and reduce errors. Business rules relate to changes made by stakeholders.
2	Department collaboration	This relates to different stakeholders coming together and collaborating to deliver certain tasks or initiatives.
3	Dynamic reports	These are reports that are flexible and allow for stakeholder self-service, i.e. stakeholders are able to make their own changes instead of waiting for someone to do it for them
4	Report design issue	This refers to the way report are created, e.g. do they include filters that can be used to slide and dice? Is the report visible and understandable?
5	Report visualization	This relates to users being able to view the data in the way that is easiest for them.

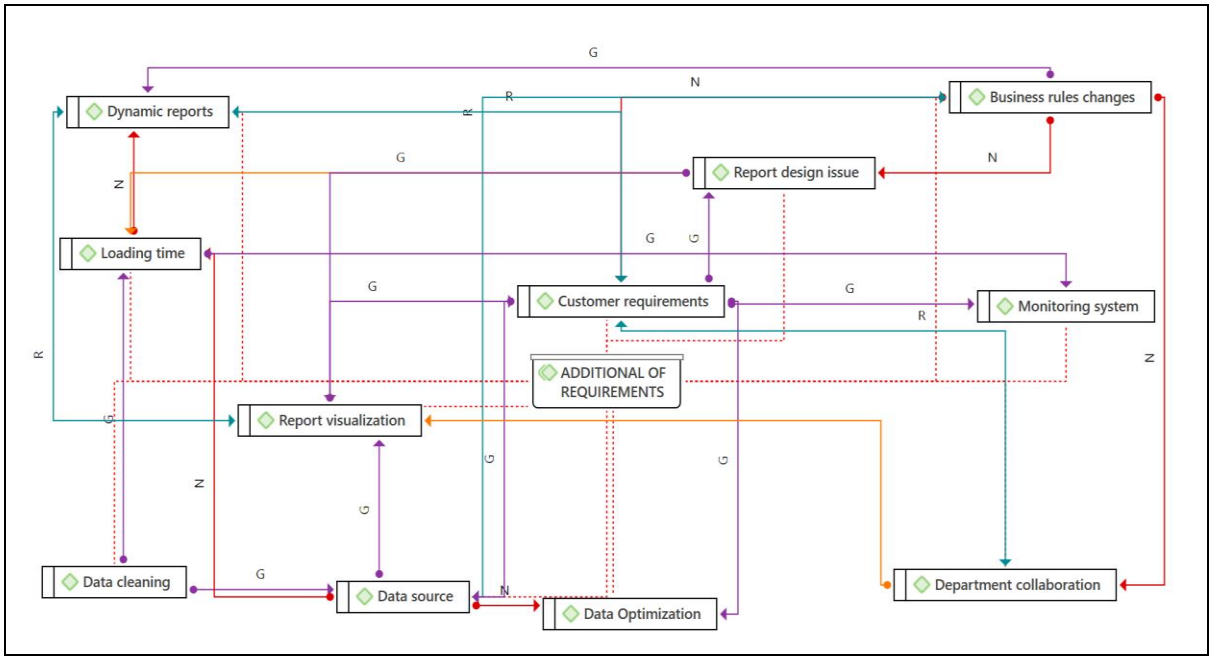

Figure 6.11: Network Diagram – Addition of Requirements (Author's Compilation from *Atlas.ti*)

b) Excerpts from the Interviews

Of the 11 codes identified, the following four codes were covered in section 6.3.6.1, namely, loading time, data cleaning, data optimisation and customer requirements; as a result, the verbatim quotes pertaining to them will not be shown again below. Similarly, in the sections that follow, the quotes that have already been covered will not be covered again in order to avoid repetition. The remaining eight codes will now be discussed with the support of verbatim quotes from the interviews.

Dynamic Reports

> Excerpt 21:9, p3, 'Like your, solution it's dynamic so that you don't really have to have issues when you have to enhance it means needs to be aligned like you, have to have a common layer where you actually can be able to be flexible when it comes to your report and I mean enhancements.'
>
> Excerpt 25:8, p2, 'think the issue is unavoidable the reason being is the layout in the format is based on regulator and as changes occur within the environment, the reporter dashboard needs to adjust and display accordingly.'
>
> Excerpt 6:19, p6, 'K, I think as developers has like when we create report, we need to create it in a manner that we think even like for the future like, say, tomorrow you're no longer working for the bank and then somebody needs to still continue using the report that you developed, so we need to make it dynamic like in a way that it updates itself,'

Report Visualization

> Excerpt 31:10, p4, 'What you can do with certain tools in the like the number of volumes you can load which only makes sense to that extent because if you are talking of dashboarding and reporting you are talking of sort of visualisation and you know not going into details and showing millions of lines of records'
>
> Excerpt 8:6, p2, 'So, we had to prioritise the needed visuals. The changes of the requirements that are not needed. We didn't have to add them.'
>
> Excerpt 3:7, p3, 'I think what can be done there is to look at how the visualisation of the report is currently done right and to actually check if the picture that you're trying to paint on a report can be understood by the user.'

Report Design Issue

> Excerpt 6:10, p4, 'OK, I think what can be done is to relook at the design of the report. Like for example, if you've got six visuals in one page, maybe try to divide the visuals,

maybe put some of those visuals on the next page and then give more information as well …'

Excerpt 20:11, p4, 'You know, report design it's an art, right, it's an art some people don't like clicks and clicking buttons and all that. Some people prefer that right? Some people don't like graphs and visualisations, they want our tables matrix.'

Business Rules Changes

Excerpt 1:29, p10, 'we sit together and we also change the business rules on our side to make sure that we are aligned.'

Excerpt 25:19, p4, 'So as segmentation occurs or changes in segmentation due to code being due to filters being hard coded reports do not adapt to business rule changes. It would be best to adopt a more dynamic type of reporting filter, that would cater for business rule changes like segment code etc.'

Excerpt 9:8, p5, 'So how they can resolve this in future they need to communicate to us once the rules, the GL, GL accounts allocation rules have changed so that we can cater for from the scripts that we run for them on monthly basis.'

Department Collaboration

Excerpt 20:14, p5, 'There's no way that I'm going to understand the report first time, right? I need someone to guide me through the report and then I'll then read the report right, again it comes with you understanding the business.'

Excerpt 9:15, p3, 'So, for me, with the specific one that I mentioned, because it was coming from different business areas, I believe that if business users can sit together and agree, what is it that you want to see?'

Excerpt 19:33, p4, 'Continuous communication on the requirements'

Excerpt 27:25, p8, 'So yeah, that kind of collaboration between multiple teams and have just one single report in state of heavy multiple reports.'

c) Relating BI Banking Reports Issues (Codes) to BIBRUC and BIBRUCUP

Based on the codes identified regarding the network and the associated excerpts, the BI banking reports issue extracted from the CIL is one that resonated with the interviewees. Multiple BIBRUC and BIBRUCUP were observed regarding this issue and the codes related to BIBRUC and BIBRUCUP (see Table 6.3) will now be discussed:

- The usability criterion that resonates with the code '*Dynamic Reports*' is *customisability*.

    - *Customisability*, as this will allow the developer to think more broadly than their current scope to cater for any future user requirements.

- The usability criterion that resonates with the code '*Data Source*' is *mapping.*

    - *Mapping* because if the report and the data source to which the report is supposed to read are not populated, users will not be able to perform their tasks.

- The usability criterion that resonates with the '*Report Visualisation*' code is *visibility.*

    - *Visibility* because when users require changes to be made to the dashboard, one of the interviewees mentioned that one has to ensure that the user clearly understands the picture you are trying to portray in the report. This will make performing their tasks more manageable.

- The usability criteria that resonate with the '*Report Design*' code are *efficiency* and *visibility*.

    - *Efficiency* because to enable users to do their work, reports should be designed to support their preferences.
    - *Visibility* because some reports are clustered in a way that one cannot see or understand what is happening in the report. As one of the interviewees stated, if there are multiple visuals on one report, then it is best for developers to structure these so that everything is visible at once.

- The usability criterion that resonates with the '*Business Rules Changes*' code is *effectiveness.*

    - *Effectiveness* because since the business rules are changing and the reports need to keep up with the changes, the way the reporting back end is developed is critical to allow for changes to be made dynamically by automating instead of creating static reports.

- The usability criterion that resonates with the '*Department Collaboration'* code is *Effectiveness*.

    - *Effectiveness* because if the users and developers collaborate to attain the same goal, i.e. the reports, and agree on the format of the report, it will ensure the *effectiveness* of the report produced. The other criterion that resonates with this is familiarity. If users are using the report for the first time, some reports will be understood at first glance; however, in this case, the interviewee did not understand the report and had to go through it to gain an understanding.

Table 6.4 shows the codes and their associated BIBRUC and BIBRUCUP, as discussed.

Table 6.4: Addition of Requirements and Associated BIBRUC and BIBRUCUP

No	Code	Usability criteria
1	Dynamic reports	Customisability
2	Data source	Mapping
3	Report visualization	Visibility
4	Customer requirements	Effectiveness
5	Report design issue	Efficiency & visibility
6	Business rules changes	Effectiveness
7	Monitoring system	Recoverability & feedback
8	Department collaboration	Effectiveness & familiarity
9	Loading time	Responsiveness & efficiency
10	Data cleaning	Mapping
11	Data optimization	Responsiveness

6.3.6.3. Reports are Not Usable

a) Codes and the Network Diagram

This theme refers to situations where users find that reports are not usable, sometimes requiring assistance or training on how to use them. Table 6.5 shows the codes and their respective descriptions, while Figure 6.12 depicts the network diagram containing the 15 codes identified together with their relationships and theme name.

Table 6.5: Reports are not Usable Code and Code Descriptions

No	Code	Description
1	Data quality	This relates to the state of data that is being used and stored, e.g. is the data of high quality, can it be trusted?
2	How to guide/navigation	This refers to the ability to provide overall descriptions of the reports so that users who are unfamiliar with them are able to find their way through them.
3	Report understanding	Refers to a lack of understanding on the part of the user of a report and the support they require to understand it.
4	Skilled team	This refers to the skills that each team member possesses for performing their duties
5	Unresolved issues	This refers to any BI banking report issues that may not have been resolved.

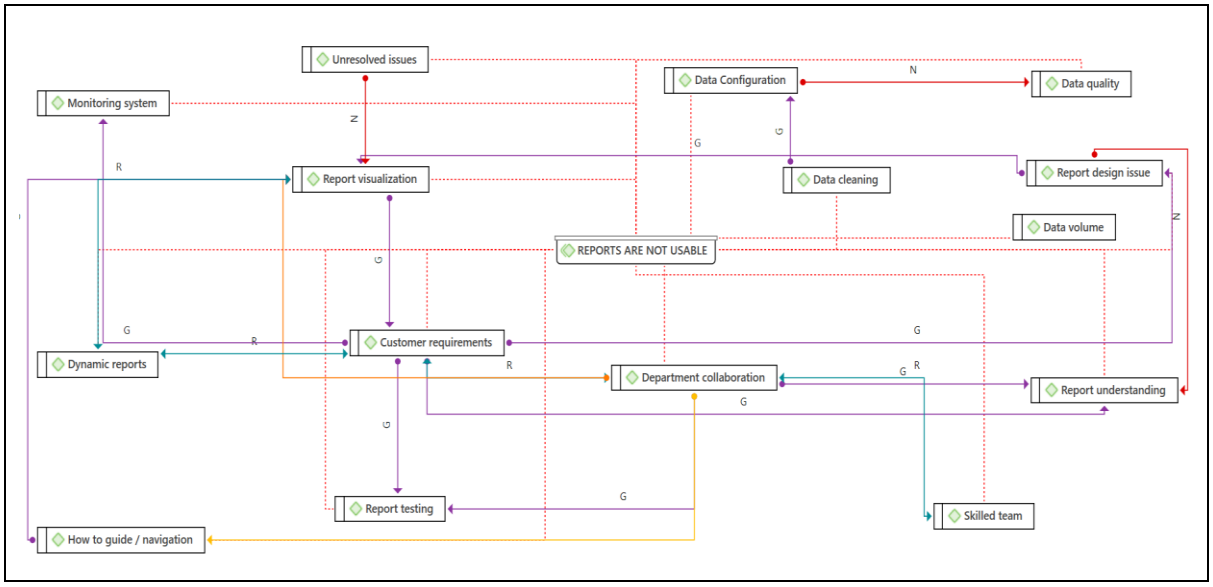

Figure 6.12: Network Diagram – Reports Are Not Usable (Author's compilation from *Atlas.ti*)

b) Excerpts from the Interviews

Of the 15 codes identified for this theme, 10 codes have been covered previously, as a result the verbatim quotes for *Report Understanding, Data Quality, Unresolved Issues, How to Guide/Navigation and Skilled Team* only will be covered below.

Report Understanding

> Excerpt 3:42, p3, 'Yes, yes, there were instances of that. So, I think they is when you can, you can't really understand that data that is depicted on the report.'
>
> Excerpt 30:11, p3, 'Yes, I have a. It's mostly. What's this? It was called seven seas. It's got a lot of graphs that I couldn't understand.'
>
> Excerpt 24:23, p4, 'I'm not skilled in a sense to explain to you how, but what I know is that when I looked into that dashboard, it was confusing to me to understand what they're trying to do.'
>
> Excerpt 23:32, p3, 'For that dashboard you just it difficult to understand. So, what we are trying to push now we need to create a simple dashboard like when I mean by simple, you know a dashboard shouldn't have like lots of filters, so that people won't understand. I'm going to make an example.'

Data Quality

> Excerpt 21:18, p4, 'So, I think like what needs to be done is like when you like the underlying sources needs to make sure that the date the data that they're providing it's of good quality,'
>
> Excerpt 14:17, p6, 'we should have a proper data quality check, checks applied.'
>
> Excerpt 27:12, p4, 'More data management like so those data quality checks should be done.'
>
> Excerpt 3:15, p5, 'So, I think there is a data quality issues right that are not that are not really fixed and maybe from a system perspective, the system guys didn't know that they should have populated value in there, so it just comes with null values.'
>
> Excerpt 5:15, p4, 'That will make inconsistent on production, but in Dev it also in a case, how is it being Dev? Because data from source most of the time is they have data quality.'

Unresolved Issues

Excerpt 29:22, p3, ‘The report was turned off. It wasn't resolved. The report was turned off, yeah.’

How to Guide/Navigation

Excerpt 11:35, p3, ‘To sort of put in descriptions on, say, multiple tabs of the report to say what is this tab focusing on or put a landing page that's going to explain the report itself.’

Excerpt 1:41, p6, ‘it is good maybe to have a, maybe a simple data dictionary on Excel spreadsheet that can be attached to the report that users can use to read and understand what does this report do? What is the purpose of this report?’

Excerpt 4:12, p3, ‘It's quite difficult because one I as a user should be able maybe to play around with the report, maybe and get familiar with the report. Or maybe a sort of training or quick how to and navigate and manual for dashboard and reporting should probably or it can assist.’

Excerpt 27:26, p4, ‘What needs to be done? Yes, I know that they are training, then there, is like is much better navigation process. If I can put it that way. So, it should be easy for us to navigate these reports about tables and so on.’

Excerpt 19:15, p5, ‘Like I said, you need to have a summary page or an overview that give a high-level explanation to say what this report, what is the intention of the report …’

Skilled Team

Excerpt 14:29, p5, ‘The BI business intelligence team which works on creating these reports and dashboard should be skilled enough.’

c) Relating BI Banking Reports Issues (Codes) to BIBRUC and BIBRUCUP

- The usability criteria that resonate with the ‘*Report Understanding’* code are *familiarity* and *task conformance*.
    - *Familiarity* because the users could not understand the reports, mentioning that the reports were confusing and that the developer should do better when creating future dashboards.
    - *Task conformance* because the reports should be built in such a way that they are able to support the user who needs to understand the report to do their work.

- The usability criteria that resonate with the '*How-to Guide/Navigate'* code are *task conformance and familiarity*.
    - *Task conformance* because the how-to guide will support users in carrying out their tasks by explaining what each functionality or metadata displayed on the report means. This, in turn, will make performing their tasks easier.
    - *Familiarity* because the report manual enables users to familiarise themselves with the reports.
- The usability criteria that resonate with the '*Unresolved Issues*' code and '*Skilled Team*' codes are *efficiency* and *effectiveness*.
    - *Efficiency* because if there are unresolved issues caused by the way the report was created, users may resort to turning off the report as it does not assist them to perform their tasks. If the developers have the skills needed to develop reports, then they can carry out their tasks efficiently.
    - *Effectiveness* because if the users do not have the skills needed to complete the tasks or the reports have issues that are unresolved, the users will not be able to complete their tasks.
- The usability criteria that resonate with needed '*Data quality*' code are *mapping* and *effectiveness*.
    - *Mapping* because data quality issues are not fixed at the source. Consequently, the output, i.e. the data displayed in the report, will not be an accurate reflection of the current situation.
    - *Effectiveness* because when data is not in a usable condition users will not be able to complete their tasks.

Table 6.6 contains all the codes that support the reports that are not usable BI banking report issues, including the ones covered in the previous sections.

Table 6.6: Reports are not Usable and Associated BIBRUC and BIBRUCUP

No	Code	Usability criteria
1	Report understanding	Familiarity & task conformance
2	Data quality	Mapping & effectiveness
3	Unresolved issues	Efficiency & effectiveness
4	How to guide/navigation	Task conformance & familiarity

No	Code	Usability criteria
5	Skilled team	Efficiency & effectiveness
6	Data cleaning	Mapping
7	Data configuration	Responsiveness & recoverability
8	Department collaboration	Effectiveness & familiarity
9	Report testing	Effectiveness
10	Customer requirements	Effectiveness
11	Monitoring system	Recoverability & feedback
12	Dynamic reports	Customisability
13	Report design issue	Efficiency & visibility
14	Report visualization	Visibility
15	Data volume	Responsiveness & efficiency

6.3.6.4. Clear Understanding of the Report

a) Codes and the Network Diagram

This theme refers to situations where the user does not understand the report. Table 6.7 shows the codes and their respective descriptions, while Figure 6.13 depicts the network diagram which contains eight codes, of which seven were covered in the previous sections.

Table 6.7: Clear Understanding of the Report Code and Code Descriptions

No	Code	Description
1	Familiarity with the report	This refers to the need for stakeholders to go through the reports, and analyse and explore them, in order to become familiar with them.

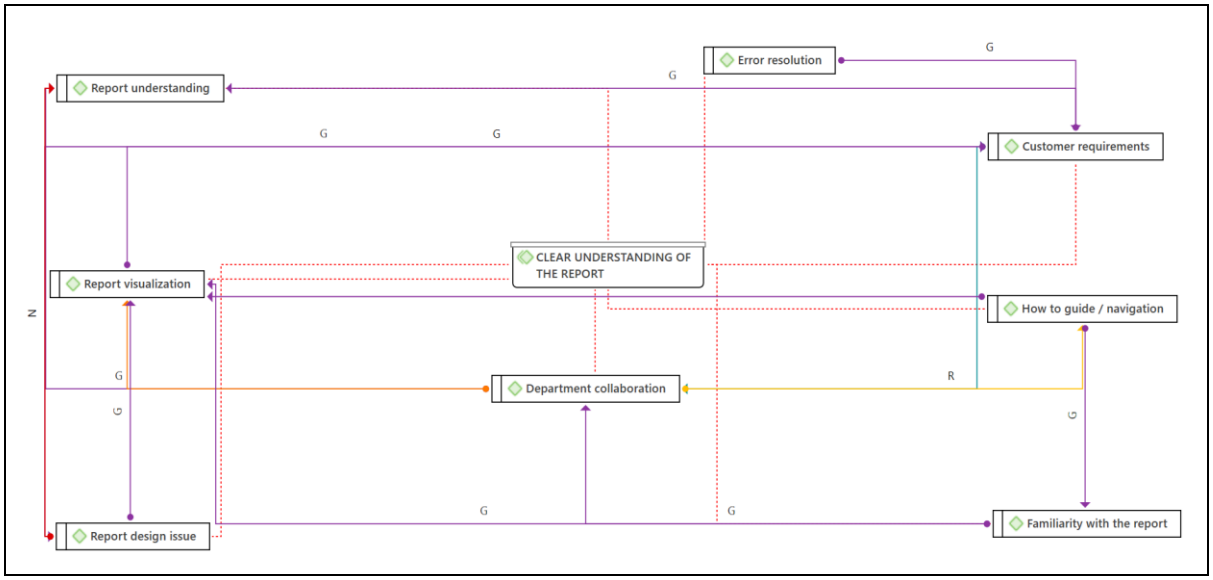

Figure 6.13: Network Diagram – Clear Understanding of the Report (Author's compilation from *Atlas.ti*)

b) Excerpts from the Interviews

The only code that will be covered in this section is *Familiarity with the Report* as the others depicted in Figure 6.13 have been covered in the previous sections. The verbatim quotes for *Familiarity with the Report* are provided below.

Familiarity with the Report

> Excerpt 4:12, p3, 'It's quite difficult because one I as a user should be able maybe to play around with the report, maybe and get familiar with the report. Or maybe a sort of training or quick how to and navigate and manual for dashboard and reporting should probably or it can assist.'
>
> Excerpt 4:32, p3, 'I'm not much. I think it maybe if the report is new then you just trying to analyse it and understand it.'
>
> Excerpt 6:13, p5, 'OK, I think as developers we just need to go through the report, especially if maybe you are not the first person to develop that report. If it was handed over to you, I think you need to go through the report and make sure that you are familiar with it.'

c) Relating BI Banking Report Issues (Codes) to BIBRUC and BIBRUCUP

- The usability criteria that resonate with the '*Familiarity with the report'* code are *Familiarity* and *Task conformance*.
    - *Familiarity* because, in line with the code *Report understanding* relating to the user-friendliness of the report, the users do not understand the reports because they were either new or had been handed over and needed to be reviewed to be understood.
    - *Task conformance* refers to the *How-to guide/navigation* code taken from the report user-friendliness BI issue.

Table 6.8 contains all the codes supporting this BI banking report issue together with the respective BIBRUC and BIBRUCUP, as covered in the previous sections.

Table 6.8: Clear Understanding of the Report and Associated BIBRUC and BIBRUCUP

No	Code	Usability criteria
1	Familiarity with the report	Familiarity & task conformance
2	Report understanding	Familiarity & task conformance
3	Report visualization	Visibility
4	Report design issue	Efficiency & visibility
5	Department collaboration	Effectiveness & familiarity
6	Error resolution	Responsiveness
7	Customer requirements	Effectiveness
8	How to guide/navigation	Task conformance & familiarity

6.3.6.5. Inconsistency of the Data

a) Codes and the Network Diagram

This theme refers to situations where data in the reports or the data warehouse (DW) that is the source of reports is inconsistent. Table 6.9 shows the codes and their respective

descriptions, while Figure 6.14 shows the network diagram containing 18 codes of which 14 have not been covered previously.

Table 6.9: Inconsistency of the Data Code and Code Descriptions

No	Code	Description
1	Business rules standards	Set of rules that governs the business.
2	Data availability	This refers to the data made available for use by users.
3	Data tool investment	This refers to an organisation investing in the multiple tools on the market that its teams require to ETL the data.
4	Job failure	This refers to the failure of the ETL job to load the data from the source to the target. This failure may have multiple causes such us poor connectivity

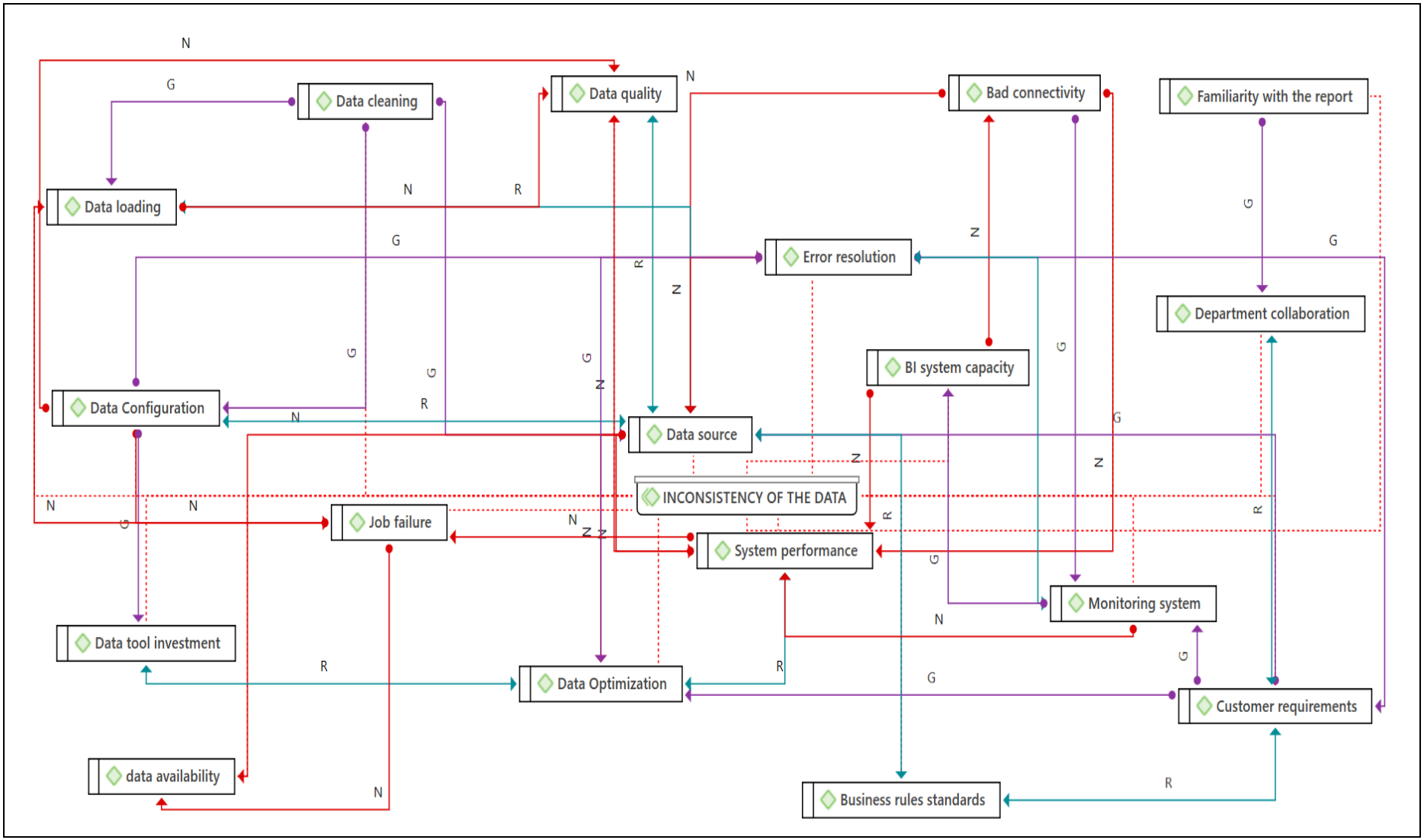

Figure 6.14: Network Diagram – Inconsistency of the Data (Author's compilation from *Atlas.ti*)

b) Excerpts from the Interviews

The only codes that will be covered in this section are *Business Rules Standards*, *Data Tool Investment*, *Job Failure* and *Data Availability,* as the others are depicted in Figure 6.13 and covered in the previous sections. The verbatim quotes are provided below.

Business Rules Standards

> Excerpt 3:44, p7, ‘So, on aligning with business rule, right, I think we can set a standard of different rules when it comes to, type of reporting.’
>
> Excerpt 3:27, p7, ‘So, this is what I said. Now with this one it would be that there isn't a standard of defining the business rules on what on the common data sets that are currently being used. So, people define their own, rules which then create this this inconsistency or misalignment.’

Data Tool Investment

> Excerpt 4:16, p4, ‘And suggestion was why can't they invest in platforms that can try to report near real time and by near time it feels to the latest data we can have is from a day before, but apparently certain industries, certain sectors do not have tools or they cannot do that of which I still strongly believe that's not the case, because if we're dealing with huge amounts of data and during our calls or Twitter data which is big data or Facebook data, that can be analysed in real time so, in any other industry.’
>
> Excerpt 4:22, p6, ‘It goes back to my tools, invest in near real time tools. Optimisation, optimise, optimise, optimise.’

Job Failure

> Excerpt 1:38, p9, ‘You might find out maybe my report only have data until July and then reason being maybe the job that was supposed to load the tables failed and no one ever checked,’
>
> Excerpt 28:18, p3, ‘I have and that will be when the job is failed a job that loads data into a database where the report is reading from.’
>
> Excerpt 8:28, p4, ‘So, we found that most reports were not being scheduled correctly, they were not automated to run on a frequent basis, so they were either not running or either they were failing.’

Data Availability

Excerpt 21:27, p5, ‘If it's, the underlying data you need to tell I mean them that your SLAs is like when are you expecting the data to be available for your report to be up to date.’

Excerpt 21:39, p4-5, ‘So, if you have no data availability at the point in time your report will be What do you believe was done to fix the BI report issue you encountered, or you associate with? misaligned. So, which is going back to making sure that when you're reports when you run your report, you have your, data that you will be running your report on like available.’

c) Relating BI Banking Report Issues (Codes) to BIBRUC and BIBRUCUP

- The usability criterion that resonates with the ‘*Business Rules Standards’* code is *Consistency*.
    - *Consistency* because if there are business rule standards, this will enforce consistency across different reports, particularly for standard data sets, so that when users from different business units use the standard data, they are able to report on the same thing.
- The usability criterion that resonates with the ‘*Data Tool Investment’* code is *effectiveness*.
    - *Effectiveness* because if the banking industry invests in competitive tools for data and reporting, better reporting and better report development will ensue.
- The usability criterion that resonates with the ‘*Data Availability’* code is *Effectiveness*.
    - *Effectiveness* because the data is unavailable as there are no service level agreements (SLAs) in place to ensure that the data required for the reports is obtained. This will affect users’ ability to perform their tasks.
- The usability criterion that resonates with the ‘*Job Failure’* code is *mapping*.
    - *Mapping* because if the job fails the job that loads the data fails, resulting in inconsistency that affects the data used for reporting. In addition, if the report is not refreshed in its entirety, inconsistent data will result.

Table 6.10 contains all the codes that support this BI issue as well as the codes covered in the previous sections, which are also part of this BI issue.

Table 6.10: Inconsistency of the Data and Associated BIBRUC and BIBRUCUP

No	Code	Usability criteria
1	Business rules standards	Consistency
2	Data tool investment	Effectiveness
3	Job failure	Mapping
4	Data availability	Effectiveness
5	Bad connectivity	Responsiveness & effectiveness
6	BI system capacity	Multi-threading
7	Data cleaning	Mapping
8	Data configuration	Responsiveness & recoverability
9	Data loading	Responsiveness & efficiency
10	Data optimization	Responsiveness
11	Error resolution	Responsiveness
12	Monitoring system	Recoverability & feedback
13	Data source	Mapping
14	Customer requirements	Effectiveness
15	System performance	Responsiveness & effectiveness
16	Department collaboration	Effectiveness & familiarity
17	Familiarity with the report	Familiarity & task conformance
18	Data quality	Mapping & effectiveness

6.3.6.6. Misalignment of Reporting

a) Codes and the Network Diagram

This theme refers to situations where reports are misaligned, for example report 1 and report 2 report on the same measures (e.g. number sales per product) but the values shown in the reports differ. Table 6.11 shows the codes and their respective descriptions, while Figure 6.15 depicts the network diagram which consists of 13 codes, of which 12 have been covered in the previous sections and one is covered in this section.

Table 6.11: Misalignment of Reporting Code and Code Description

No	Code	Description
1	Data inconsistency	This relates to the presence of different versions of the same data as stored or used.

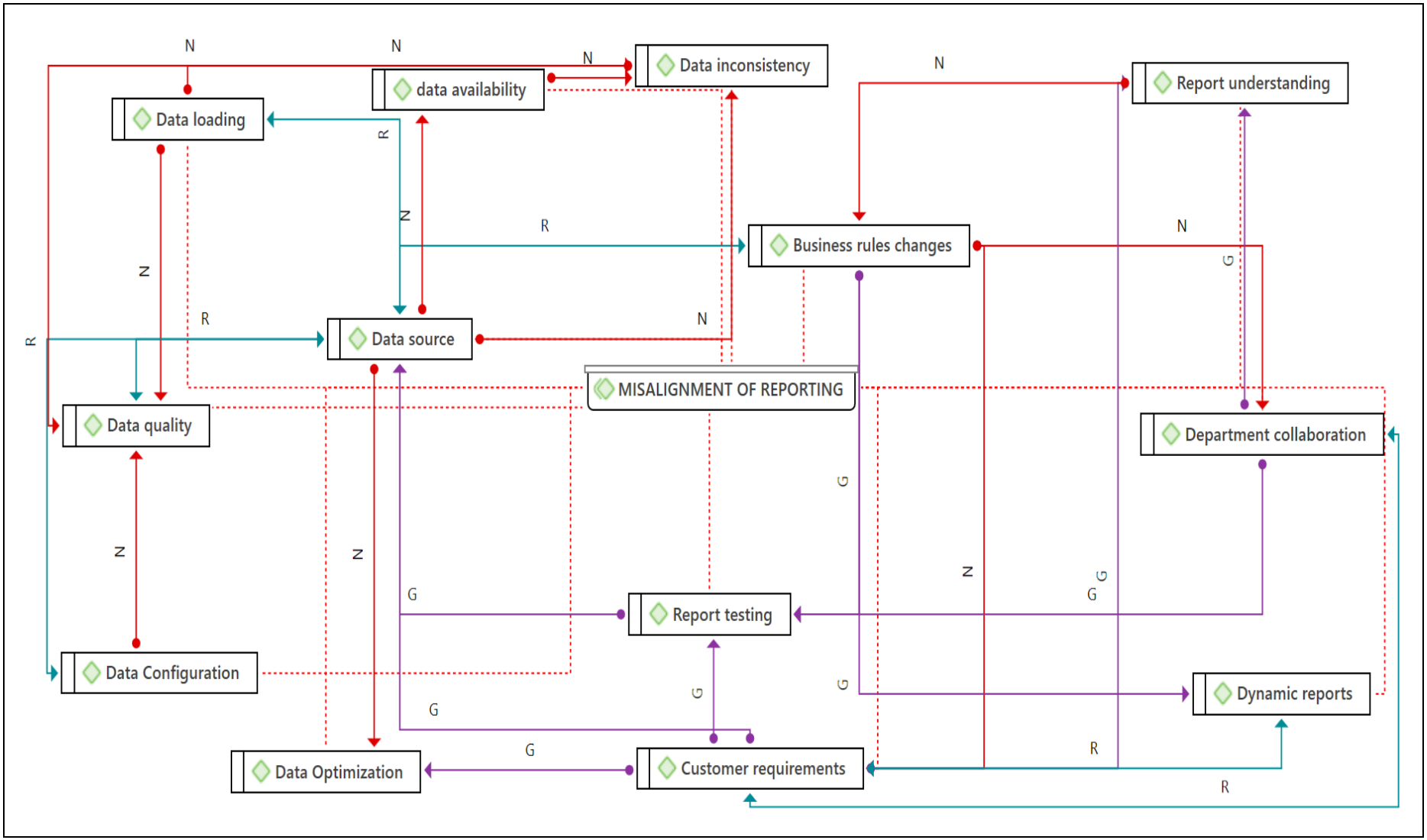

Figure 6.15: Network Diagram – Misalignment of Reporting (Author's Compilation from *Atlas.ti*)

b) Excerpts from the Interviews

The only code that will be covered in this section is *Data Inconsistency,* as the others depicted in Figure 6.14 have been covered in the previous sections. The relevant verbatim quote is presented below.

Data Inconsistency

> Excerpt 13:13, p4, 'If the data was not the source, data was not refreshed to them to have like different inconsistencies.'

c) Relating BI Banking Issues (Codes) to BIBRUC and BIBRUCUP

- The usability criteria that resonate with the '*Data Inconsistency'* code is *consistency*.
    - *Consistency* because the data would be inconsistent between the source and the target or reports when they load the data to make it available for users. Table 6.12 contains all the codes that support this BI issue and the codes covered in the previous sections, which are also part of this BI issue.

Table 6.12: Misalignment of reporting and Associated BIBRUC and BIBRUCUP

No	Code	Usability criteria
1	Data inconsistency	Consistency
2	Report testing	Effectiveness
3	Customer requirements	Effectiveness
4	Dynamic reports	Customisability
5	Business rules changes	Effectiveness
6	Department collaboration	Effectiveness & familiarity
7	Report understanding	Familiarity & task conformance
8	Data availability	Effectiveness
9	Data configuration	Responsiveness & recoverability

No	Code	Usability criteria
10	Data loading	Responsiveness & efficiency
11	Data Optimization	Responsiveness
12	Data source	Mapping
13	Data quality	Mapping & effectiveness

6.3.6.7. Up-to-date Reporting

a) Codes and the Network Diagram

This theme refers to situations where published reports are not updated and thus show out-of-date data, and not the current data expected. Table 6.13 shows the codes and their respective descriptions, while Figure 6.16 depicts the network diagram consisting of 16 codes, of which 15 have been covered in the previous sections and one will be covered in this section.

Table 6.13: Up-to-date Reporting Code and Code Description

No	Code	Description
1	Report access	In line with the Protection of Personal Information Act (POPIA), this refers to the management of access to reports to ensure that such access is only granted to those using reports.

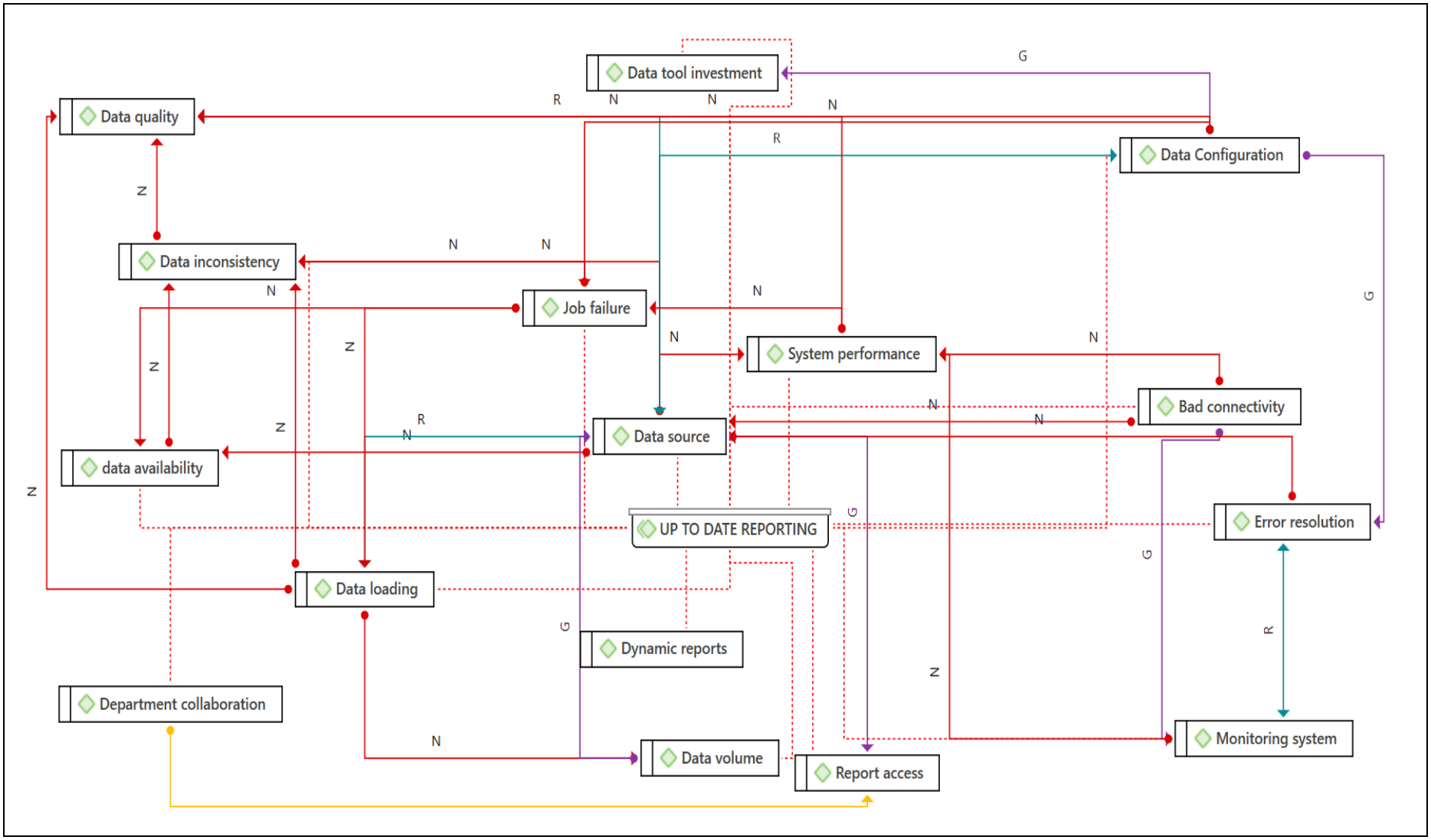

Figure 6.16: Network Diagram – Up-to-date Reporting (Author's Compilation from *Atlas.ti*)

b) Excerpts from the Interviews

The only code that will be covered in this section is *Report Access* as the others depicted in Figure 6.15 have been covered in the previous sections. The verbatim quotes pertaining to this code are presented below.

Report Access

> Excerpt 31:35, p8, 'So if you don't have access to a certain report, you sort of have to sort of go through the whole access and you know requests process to be able to have access to it.'
>
> Excerpt 5:25, p6, 'all new users must request access in advance before accessing it and then for the old user It's only going to happen if they revoke the excess.'
>
> Excerpt 28:14, p5, 'we had to make sure that we grant the users the correct access.'
>
> Excerpt 8:27, p4, 'And so, on that one, it was an issue of access where we needed to locate the owner and ask the owner to grant access.'

c) Relating BI Banking Issues (Codes) to BIBRUC and BIBRUCUP

- The usability criterion that resonates with the '*Report Access'* code is *effectiveness*.
    - *Effectiveness* because users cannot perform their tasks without access; there are instances where users need the report owner to grant them access to reports because the owner has limited access.

Table 6.14 contains all the codes that support this BI issue as well as the codes covered in the previous sections, which also form part of this BI issue.

Table 6.14: Up-to-date reporting and Associated BIBRUC and BIBRUCUP

No	Code	Usability criteria
1	Report access	Effectiveness
2	Data volume	Responsiveness & efficiency
3	Error resolution	Responsiveness
4	Monitoring system	Recoverability & feedback

No	Code	Usability criteria
5	Customer requirements	Effectiveness
6	Bad connectivity	Responsiveness & effectiveness
7	Data source	Mapping
8	System performance	Responsiveness & effectiveness
9	Data inconsistency	Consistency
10	Report testing	Effectiveness
11	Dynamic reports	Customisability
12	Department collaboration	Effectiveness & familiarity
13	Data availability	Effectiveness
14	Data loading	Responsiveness & efficiency
15	Data quality	Mapping & effectiveness
16	Data tool investment	Effectiveness

6.3.6.8. Misalignment of Reporting due to Incorrect Business Rules

a) Codes and the Network Diagram

This theme refers to situations where reports are misaligned as a result of incorrect business rules, for example either business rules provided by users are incorrect or the BI developer did not implement them according to requirements. This then results in, for example, report 1 and report 2 reporting on the same measures (e.g. number sales per product) but the values differing. Table 6.15 shows the codes and their respective descriptions. Figure 6.17 depicts the network diagram which consists of eight codes of which six have been covered in the previous sections and two will be covered in this section.

Table 6.15: Misalignment of Reporting due to Incorrect Business Rules Code and Code Descriptions

No	Code	Description
1	Business rule owner	Contains the subject matter expected for the business rule.
2	Incorrect business rules	Refers to transformation rules that are incorrect.

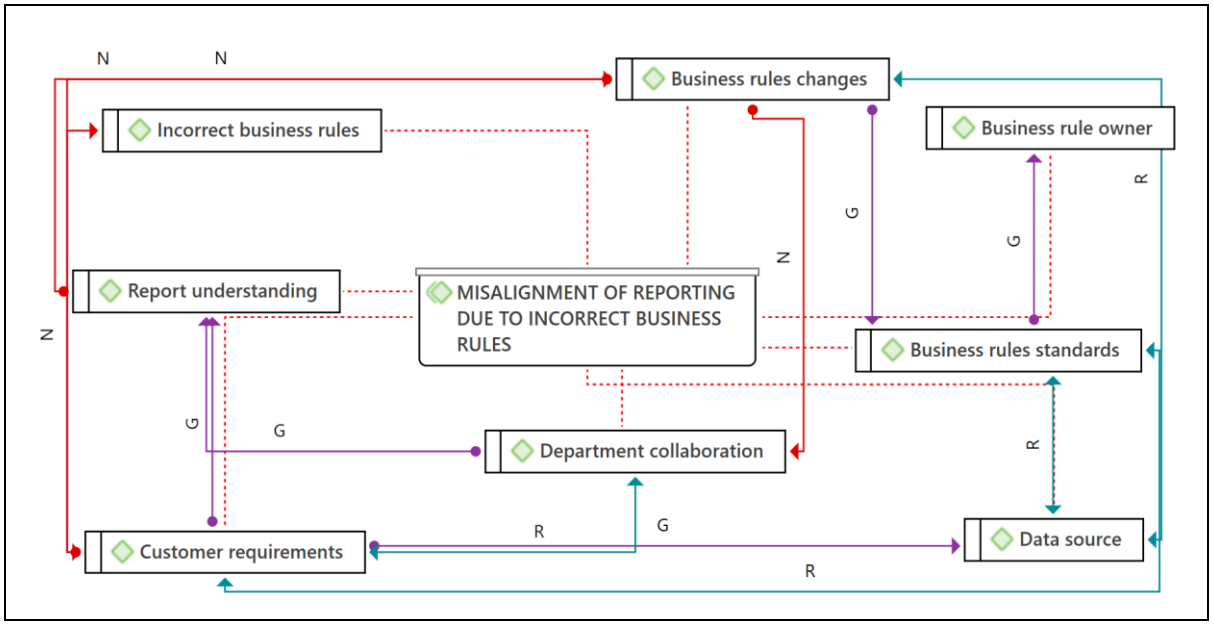

Figure 6.17: Network Diagram – Misalignment of Reporting Due to Incorrect Business Rules (Author's Compilation from *Atlas.ti*)

b) Excerpts from Interviews

The only codes that will be covered in this section are *Business Rule Owner and Incorrect Business Rules,* as the others depicted in Figure 6.17 have been covered in the previous sections. Below are the verbatim quotes.

Business Rule Owner

> Excerpt 3:45, p7, 'So, it also needs to have an owner who owns that, who owns the business rule and then it's shared across by everyone else and no one else can change that's rule besides the owner.'

Incorrect Business Rules

> Excerpt 18:22, p5, ‘Really, I'm not sure. Maybe because the rules will then be given by the business users. So, if one business user gives us the wrong rules then the reports will be basically built on that.’
>
> Excerpt 21:41, p6, ‘The rules need to be revisited like meaning the requirements you need to revisit your requirements to take what might be missing from your rules …’

c) Relating BI Banking Issues (Codes) to BIBRUC and BIBRUCUP

- The usability criterion that resonates with the ‘*Business Rule Owner’* and ‘*Incorrect Business Rules’* codes is *consistency*.
    - *Consistency,* because a lack of consistency will result in users using different numbers to report on the same metric.

Table 6.16 contains all the codes that support this BI issue as well as the codes covered in the previous sections, which are also part of this BI issue.

Table 6.16: Misalignment of Reporting due to Incorrect Business Rules and Associated BIBRUC and BIBRUCUP

No	Code	Usability criteria
1	Business rule owner	Consistency
2	Incorrect business rules	Consistency
3	Business rules changes	Effectiveness
4	Department collaboration	Effectiveness & familiarity
5	Report understanding	Familiarity & task conformance
6	Data source	Mapping
7	Customer requirements	Effectiveness
8	Business rules standards	Consistency

6.3.6.9. Inaccessibility of Reports

a) Codes and the Network Diagram

This theme refers to situations where users cannot access reports, for example when the servers are down. Table 6.17 shows the codes and their respective descriptions, while Figure 6.17 depicts the network diagram which consists of 13 codes, 12 of which have already been covered in the previous sections and one code which will be covered in this section.

Table 6.17: Inaccessibility of Reports Code and Code Descriptions

No	Code	Description
1	Data protection	This relates to the protection of data from use by unauthorised users.

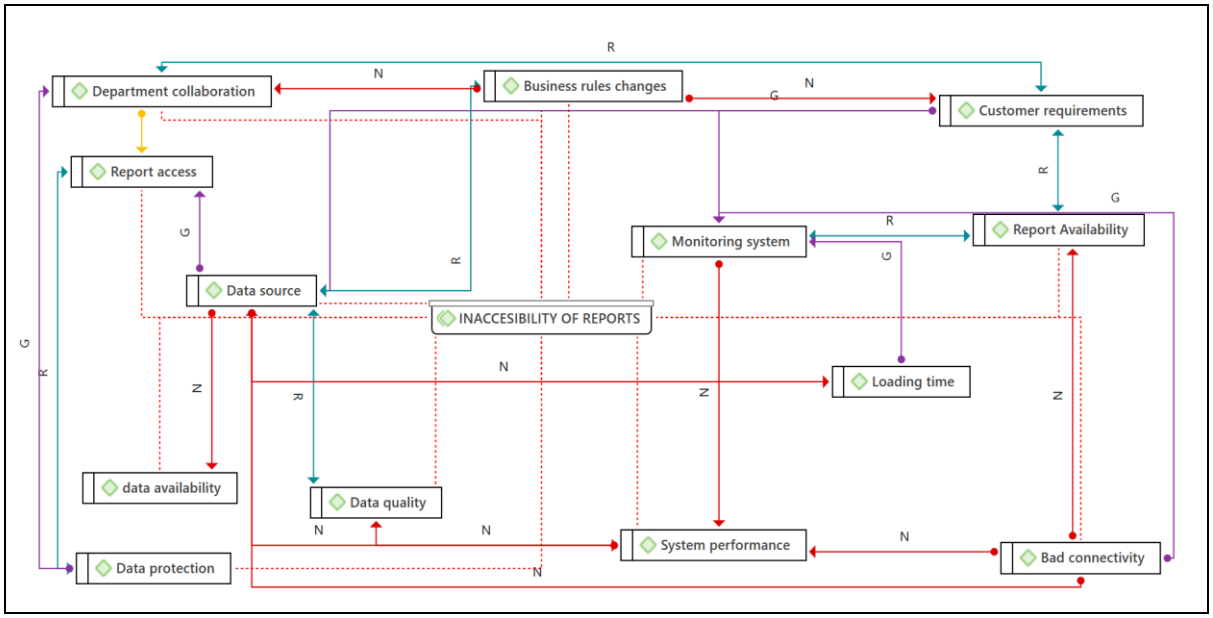

Figure 6.18: Network Diagram – Inaccessibility of Reports (Author's Compilation from *Atlas.ti*)

b) Excerpts from Interviews

The only code that will be covered in this section is *Data Protection*, as the others depicted in Figure 6.17 have been covered in the previous sections. The verbatim quotes are presented below.

Data Protection

Excerpt 1:31, p11, 'The POPI act. Not everyone should have access to all the data. You must have a be an authorised person to access certain.'

Excerpt 11:26, p5, 'Or the owner of the report be, I guess the name of the contact details of the owner of the report, be there on the report. And when I try to access the report, it says that I should apply for access from this person or apply for access on this way, using this way.'

c) Relating BI Banking Issues (Codes) to BIBRUC and BIBRUCUP

- The usability criterion that resonates with the '*Data Protection'* code is *effectiveness*.
    - *Effectiveness* because, owing to the need to comply with POPIA, access to data or reports is limited to users approved by the report owner.

Table 6.18 contains all the codes that support this BI issue and the codes covered in the previous sections, which also form part of this BI issue.

Table 6.18: Inaccessibility of the Reports and Associated BIBRUC and BIBRUCUP

No	Code	Usability criteria
1	Data protection	Effectiveness
2	Bad connectivity	Responsiveness & effectiveness
3	Report availability	Effectiveness & consistency
4	Data quality	Mapping & effectiveness
5	Report access	Effectiveness
6	Monitoring system	Recoverability & feedback
7	Data source	Mapping
8	System performance	Responsiveness & effectiveness
9	Data availability	Effectiveness

No	Code	Usability criteria
10	Business rules changes	Effectiveness
11	Department collaboration	Effectiveness & familiarity
12	Customer requirements	Effectiveness
13	Loading time	Responsiveness & efficiency

6.3.6.10. Back-end and Front-end Misalignment

a) Codes and the Network Diagram

This theme refers to situations where the report on the front-end is unaligned with the data in the DW. This means that the refreshment of the front-end report may be delayed, or that it produces duplicated records. All the codes in this section have been covered in the previous sections. Figure 6.19 shows the 15 codes that were identified for this theme.

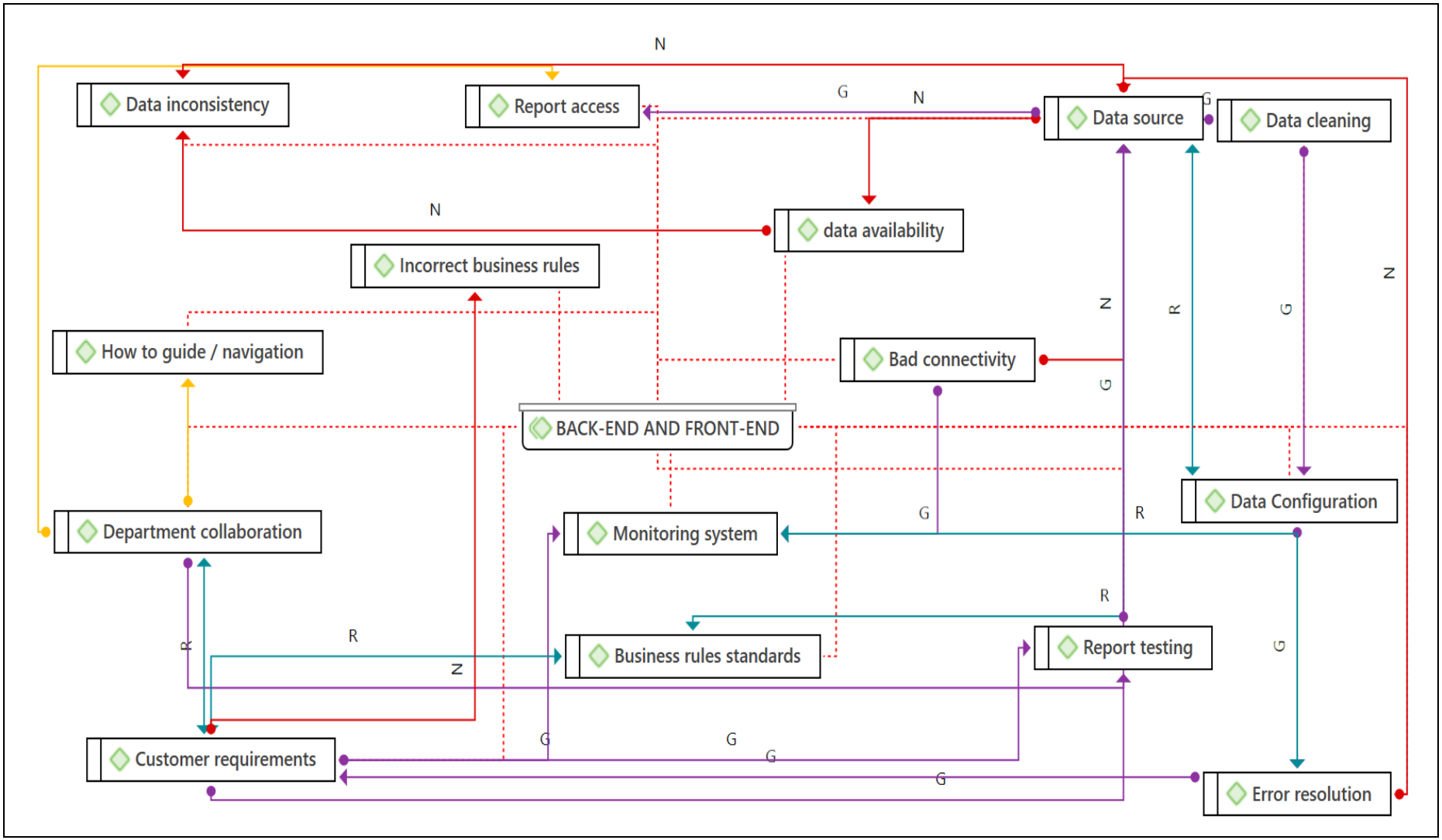

Figure 6.19: Network Diagram – Back-end and Front-end Misalignment (Author's Compilation from *Atlas.ti*)

b) Excerpts from Interviews

All the verbatim quotes for the codes depicted in Figure 6.18 have been covered in the previous sections.

c) Relating BI Banking Issues (Codes) to BIBRUC and BIBRUCUP

Table 6.19 below contains the codes extracted from the verbatim quotes from the interviews and from the network diagram depicted in Figure 6.19. All 15 codes were covered in previous sections. As a result, the relevant verbatim quotes will not be shown again here. Table 6.19 contains all the codes that support this BI issue as well as the codes covered in the previous sections, which also form part of this BI issue.

Table 6.19: Back-End and Front-End Misalignment and Associated BIBRUC and BIBRUCUP

No	Code	Usability criteria
1	Data inconsistency	Consistency
2	How to guide/navigation	Familiarity & task conformance
3	Report testing	Effectiveness
4	Incorrect business rules	Consistency
5	Business rules standards	Consistency
6	Bad connectivity	Responsiveness & effectiveness
7	Report Access	Effectiveness
8	Monitoring system	Recoverability & feedback
9	Data source	Mapping
10	Data availability	Effectiveness
11	Department collaboration	Effectiveness & familiarity
12	Customer requirements	Effectiveness

No	Code	Usability criteria
13	Error resolution	Responsiveness
14	Data configuration	Responsiveness & recoverability
15	Data cleaning	Mapping

Section 6.4 presents the findings related to user satisfaction.

6.4. Findings on User Satisfaction

Since satisfaction cannot be measured objectively like efficiency and effectiveness, the participants were asked two questions relating to satisfaction during the interviews. These questions were similar with the only difference being the answering technique applied: one was answered using ‘yes’ or ‘no’ and the other was answered on a scale of 1 to 5. Sections 6.4.1 and 6.4.2 contain the findings, with section 6.4.1 presenting the findings resulting from the yes/no question and section 6.4.2 presenting the findings in terms of the scale from 1 to 5.

6.4.1. Satisfaction – Yes or No

Prior to asking the main interview questions, the participants were asked whether they were satisfied with the BI banking report. This question required a yes or a no answer from the participants and they were also asked to substantiate their answers. Subsequently, 77% of the participants answered with a ‘yes’, meaning that they were satisfied with the report. Below is some of their reasoning for being satisfied with the BI banking reports:

- Interview 1, ‘I am satisfied with the business intelligence reports. Yes, because what they do, they bring or they provide a clear in the indication or overview of how the business is doing, how the business is performing because of the business intelligence reports and the stakeholders and management will be able to see how we are performing, where we are going and what is it that we can do in order to improve certain things within the business.’
- Interview 15, ‘I am satisfied, especially with the tools that are currently being used like power BI. And mostly a power BI, some others like for business objects as well and yeah, other reporting tools that are made use of for dashboards. I am satisfied because it's takes away that whole having to push together the graphs and everything by yourself on Excel. So, I like that functionality.’

- Interview 17, ‘I am. Well, it's yes, I am based on this user friendliness and then the amount of functionality can get out of it.’

Based on this feedback it would appear that the participants were satisfied with the BI banking reports. However, 13% of the participants answered with a ‘no’, meaning they were not satisfied with reports, with some of the participants questioning the reliability of the reports and some indicating that the reports needed to be enhanced. Some of the feedback received in this regard follows:

- Interviewee 4,’ with my experience, I've found that a lot of people Still question how the reports are done, or rather they don't solve their problem, or they don't understand them. So, the development or the manner in which they are Designed or displayed for the user? I don't think in my opinion they resolve users’ queries.’
- Interviewee 21, ‘No, the like I said, some reports are not clear, so these some work that still needs to be done there. So, if they can make their reports to be clear for everyone to understand, not just people who understand the data, like someone from business, they don't understand what they data is all about. So, they need to make them, they need to be clear, so, if they do that, maybe I'll give them a 5 but for now no.’
- Interviewee 28,’ No, source data is usually not clean. Inconsistency in the source data.’

10% of the participants were undecided about this question and said they were not sure whether they were satisfied or not – one said that at the moment it was 50/50 for them. Some mentioned that they were satisfied with some reports and not with others. As a result, the researcher added an additional category ‘maybe’ to classify their feedback. The section below contains some of the participant’s feedback:

- Interview 6, ‘Maybe firstly, it's a I think it's the tool issue or the BI tool and, in terms of the views. And you know the dimensions. Especially on the dashboards, how are they presented? The way they are presented. So, I do feel that at times, as I said, it depends on the technology, but also it goes back to the requirements on the outputs that you want to see which is the view.’
- Interview 20, ‘Not all the reports, but some of them I’m satisfied. The ones that I'm not satisfied, it's just we just need more time to enhanced them, but they are still a work in progress reports that we still have, but it will never be a final product because all use cases will always be added always be requested so the report will continue to mature, but they still pending these cases or all reporting needs that the reports still needs to be enhanced, this is now report that I have built.’

6.4.2. Satisfaction – Scale of 1 to 5

At the end of the interviews the participants were asked to rate their satisfaction with the BI banking reports overall on a scale of 1 to 5, with 1 being strongly dissatisfied and 5 being strongly satisfied. Of the 31 participants, one could not rate their satisfaction. Refer to the verbatim quote below:

- Interviewee, 'I am satisfied. I know every now and then, there will be some additions that are added especially in this industry we are in. things get changes every now and then, But I'm satisfied because each and every time when the changes that are implemented, they improve our reporting and structure of our business intelligence.'

Table 6.20 presents the participants' rating of the satisfaction usability criteria. Of those who responded, 32% of the participants rated their satisfaction as 4; 19% rated it as 3; 19% rated it as 3.5; 19% rated it as 5; 3% rated it as 4.2, 3% rated it as 4.5, and lastly, 3% did not provide a rating for their satisfaction.

Table 6.20: Participants' Rating of the Satisfaction Usability Criteria on a Scale of 1 to 5

No	Scale (between 1 to 5)	Number of Participants	Percentage
1	Scale: 3.0	6	19
2	Scale: 3.5	6	19
3	Scale: 4.0	10	32
4	Scale: 4.2	1	3
5	Scale: 4.5	1	3
6	Scale: 5.0	6	19
7	Unprovided scale	1	3

In section 6.5, data triangulation for the survey, the CIL data extraction and the interviews will be presented.

6.5. Data Triangulation for the Literature review, Survey, Company Issue Log (CIL) Data Extraction and Interview Findings

Figure 6.20 depicts the data resulting from all the data collection techniques used in this study. The results have been triangulated with the intention of revealing convergent evidence on the salience of the findings.

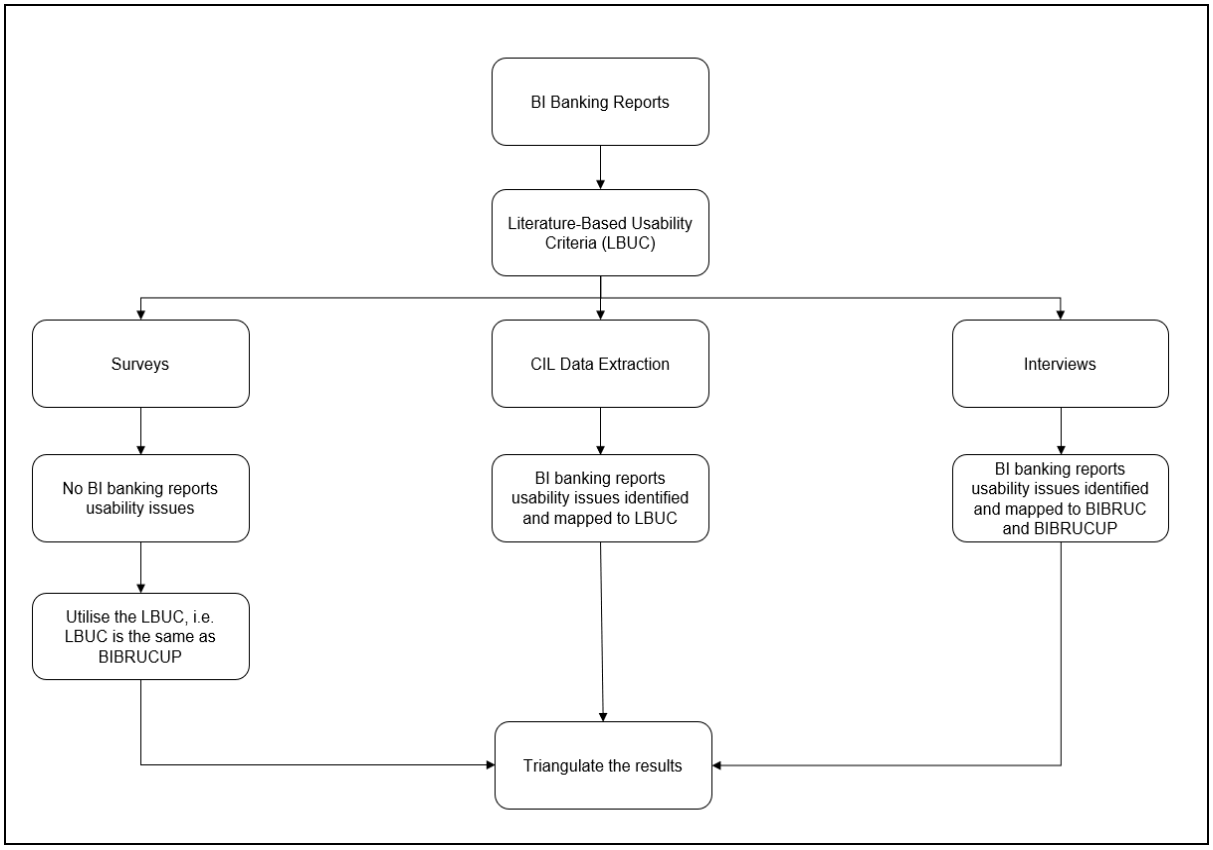

Figure 6.20: Data Triangulation Results Flow

The survey conducted sought to identify the usability criteria that should be used to evaluate the BI banking reports from a user's perspective, thereby identifying BI banking reports issues, identifying which issues were related to usability and mapping them to the LBUC. All the constructs measured scored above 3.5 and thus the results of the survey indicated that there were no BI banking reports usability issues.

The CIL data extraction consisted of extracted data pertaining to the issues users log when using the BI banking reports. These results indicated that there were indeed issues with the reports. These included usability issues, which were subsequently mapped to the LBUC to formulate the refined LBUC, referred to as BIBRUC.

The results of the survey and the CIL data extraction were contradictory and therefore interviews were conducted to confirm if indeed usability issues related to BI banking reports existed from a user's perspective and to identify the critical usability criteria that should be used to evaluate the reports. The results confirmed the presence of these issues, which were mapped to the BIBRUC and the BIBRUCUP to formulate the final set of usability criteria – CBIBRUCUP. Figure 6.21 depicts the progression of the usability criteria from a set of LBUC to a set of empirically evaluated CBIBRUCUP.

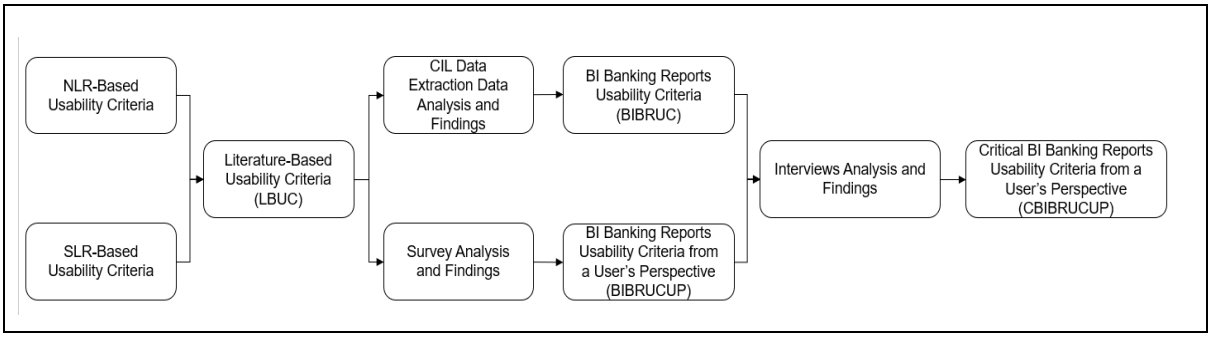

Figure 6.21: Progression of CBIBRUCUP

To answer RSQ4:' What are the critical usability criteria that should be used to evaluate the business intelligence banking reports from the user's perspective?', Table 6.21 contains the CBIBRUCUP mapping, which contains the usability category, the LBUC, BIBRUC, BIBRUCUP and lastly the CBIBRUCUP. Fourteen LBUC were deemed relevant for this study. Subsequently, of these 14, 12 were deemed critical for the BI banking reports. These 12 critical usability criteria are presented in Table 6.21. See Appendix H for all the BI banking report usability issues and their respective usability criteria. Notably, mapping the BI issues to usability criteria was based on the literature definitions of those criteria but also involved certain subjective decisions. While effectiveness and efficiency influenced most of the issues the purpose was to see which of the other criteria were relevant. Therefore, the CBIBRUCUP is suggested as a starting point for future research rather than as a final and complete set of criteria.

Table 6.21: CBIBRUCUP Triangulation

No	Category	LBUC	BIBRUCUP	BIBRUC	CBIBRUCUP
1	Learnability	Predictability	X		
2	Learnability	Familiarity	X		X
3	Learnability	Consistency	X	X	X
4	Flexibility	Multi-threading	X		X
5	Flexibility	Customisability	X	X	X
6	Robustness	Recoverability	X		X
7	Robustness	Responsiveness	X	X	X

No	Category	LBUC	BIBRUCUP	BIBRUC	CBIBRUCUP
8	Robustness	Task conformance	X	X	X
9	Usability goals	Effectiveness	X	X	X
10	Usability goals	Efficiency	X	X	X
11	Usability goals	Satisfaction	X	X	X
12	Usability design principles	Visibility	X		X
13	Usability design principles	Feedback	X	X	
14	Usability design principles	Mapping	X	X	X

Section 6.6 summarises the chapter.

6.6. Chapter Summary

In this chapter the researcher reported on the analysis performed to identify critical usability criteria for the BI banking reports. This was done based on the 10 BI banking report issues identified in Chapter 5 from the CIL data extraction, as well as the BIBRUC and the BIBRUCUP. The interviews confirmed the presence of BI banking usability issues, and these were subsequently mapped to the BIBRUC and BIBRUCUP to formulate the CBIBRUCUP. The results of the interviews contradict the findings of the survey data but do support the findings of the secondary data. This chapter further answered RSQ4 ‘What are the critical usability criteria that should be used to evaluate the BI banking reports from the user’s perspective?’ Thus, according to the findings of the study, there are 12 CBIBRUCUP that can be used to evaluate the BI banking reports from a user’s perspective.

CHAPTER 7 : DISCUSSION OF THE FINDINGS AND CONCLUSIONS

7.1. Introduction

In this chapter, the research questions are revisited to demonstrate how they have been answered and what the research limitations were. The contributions of the study are presented and contextualised by considering other research conducted while this study was in progress. In section 7.2 the researcher discusses the research findings in line with the stated research questions and objectives, while section 7.3 contextualises this study. Section 7.4 provides the limitations of the study, section 7.5 presents the contribution made, section 7.6 makes recommendations for future research and section 7.7 focuses on the researcher's reflections on this study.

7.2. Research Questions, Objectives and Key Contributions

The research questions investigated in this study were answered by following a rigorous research process. First, the main research question was introduced in section 1.3, as follows: 'What are the critical usability criteria that should be used to evaluate the BI banking reports?' To answer this question, Table 7.1 provides the sub-research questions and a summary of the contribution of this study. Included are the main research question and sub-research questions, the inputs, outputs, objectives and contributions.

Table 7.1: Research Questions, Objectives and Contributions (Final Version)

Main Research Question: What are the critical usability criteria that should be used to evaluate the business intelligence banking reports?					
Main Research Objectives: The study aims to investigate the critical usability criteria that should be used to evaluate business intelligence banking reports.					
No	**Sub-Questions**	**Sub-Objectives**	**Input**	**Output**	**Contribution**

1	What criteria are available to evaluate the usability of business intelligence reports?	To identify the criteria that are available to evaluate the usability of business intelligence reports.	NLR and SLR	List of LBUC relevant to this study.	Used as a basis for the survey, interviews and CIL data extraction output, to compare and map the findings on the data collected.
2	What are the business intelligence reports usability issues in the banking industry?	To identify the business intelligence reports usability issues in the banking industry.	LBUC and CIL data extraction	List of BI banking report usability issues mapped to the LBUC.	Synthesis of usability criteria for BI banking reports by comparing the usability issues identified from the CIL with the LBUC to identify BIBRUC.
3	What are the usability criteria that should be used to evaluate the business intelligence banking reports from the user's perspective?	To identify the usability criteria that should be used to evaluate the business intelligence banking reports from the user's perspective.	Survey	List of synthesised BIBRUCUP from Table 5.14 that will be used to evaluate the BI reports in the banking industry.	Evaluation of the BI banking report usability criteria from a user's perspective and present a list of BIBRUCUP.
4	What are the critical usability criteria that should be used to evaluate the business	To identify the critical usability criteria that should be used to	Interview	List of synthesised CBIBRUCUP from Table 6.21 that will be used to	Evaluation of the BI banking report usability criteria from a user's perspective and present a list of CBIBRUCUP.

	intelligence banking reports from the user's perspective?	evaluate the business intelligence banking reports from the user's perspective.		evaluate the BI reports in the banking industry.	

Three different techniques were used to collect data on usability criteria for the business intelligence (BI) banking reports, namely a survey, CIL data extraction and interviews. The process of collecting data involved participants from the respective bank. The study participants shared their insights about the BI banking report issues during the interviews.

The researcher first identified the literature-based usability criteria (LBUC) (Table 3.7) that could be used as a basis for the study. Thereafter, the researcher developed the survey questions to evaluate the business intelligence (BI) banking reports usability criteria from a user's perspective (BIBRUCUP) (based on the survey results, the researcher reused Table 3.7 for the LBUC, i.e. the LBUC are the same as the BIBRUCUP). Furthermore, the researcher extracted data from the CIL to identify whether BI banking report issues were present and then mapped them to the LBUC to identify the BIBRUC. The researcher developed the interview questions based on these BI banking issues together with the BIBRUC and BIBRUCUP to identify the critical business intelligence banking reports usability criteria from a user's perspective (CBIBRUCUP).

The main research question resulted in the CBIBRUCUP (see Table 6.21), given that the usability criteria were originally proposed following the literature review. This research question was answered empirically since the CIL data was able to identify the usability issues and the relevance of those criteria was evaluated during the interviews. Once the interview findings were made the criteria were updated. Figure 7.1 depicts the progression of the usability criteria from a set of LBUC to a set of empirically evaluated CBIBRUCUP to answer main research question.

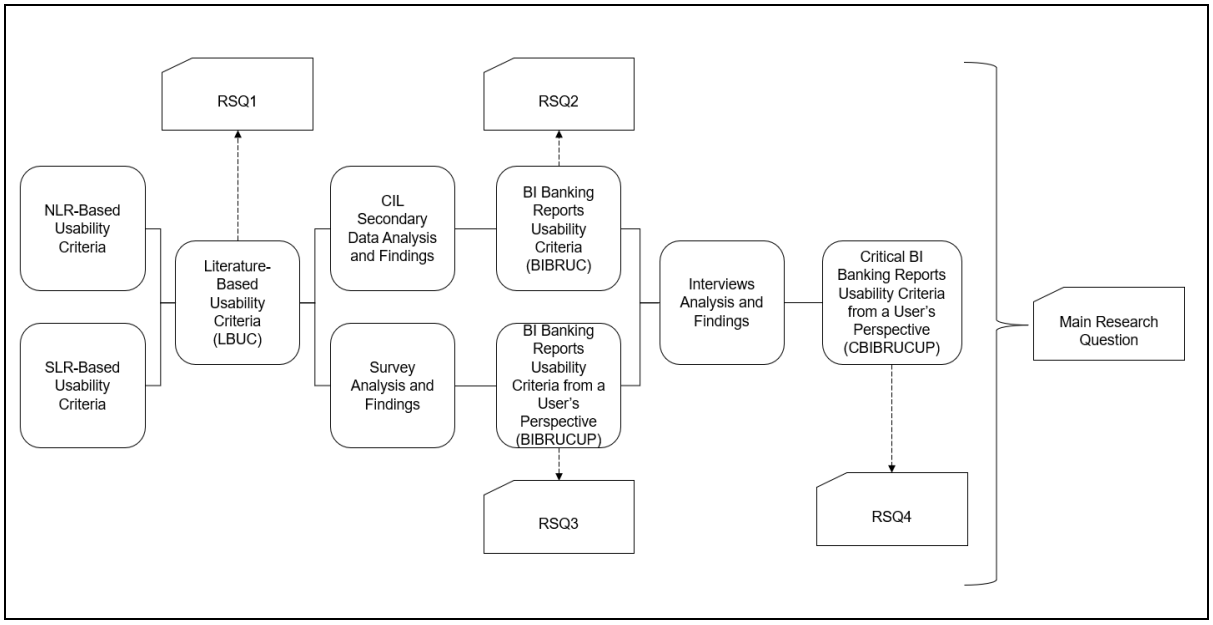

Figure 7.1: Progression of Usability Criteria to Answer Main Research Question

The list of CBIBRUCUP that could be used to evaluate the BI banking reports includes *Familiarity; Consistency; Multi-threading, Customisability, Recoverability, Responsiveness, Task conformance, Effectiveness, Efficiency, Satisfaction, Visibility and Mapping*.

Section 7.3 contextualises the study.

7.3. Contextualising the Research

This discussion highlights studies published that focused on BI banking usability criteria while the current research was conducted. This is done to contextualise the contribution of this dissertation in terms of the current literature.

- Eriksson and Ferwerda (2021) developed a theoretical framework based on existing literature and combined the literature with empirical data collected from experts in the business intelligence systems (BIS) industry in Sweden. Eriksson and Ferwerda's (2021) framework consisted of user experience (UX) strategy, product–user interaction, usability, context, agile/lean and the evaluation of high-level factors. The high-level factors were compared against during an analysis using empirical data. Following the empirical analysis, the framework was extended to cater for critical factors (subcategories of high-level factors). According to the empirical data, for the UX strategy the critical factor was *content,* while for usability the critical factors were *performance* and *education*. The study further revealed that usability is a key factor for a positive UX in BIS.

    - Compared to this dissertation, the study by Eriksson and Ferwerda (2021) was on a more abstract level and it did not have the detailed constructs that this dissertation contains.
- Beelders and Kotzé (2020) investigated the probable causes of the low utilisation of BI and tested the inclusion of a usability process in BIS use. The study utilised an off-the-shelf tool and conducted a feasibility study to determine whether eye-tracking is viable as a means of determining the reason for existing usability problems. The usability criteria utilised for their study were those of Jooste et al. (2014). The study results showed that usability should be enhanced before the release of BI tools, which could potentially increase the usage and adoption of BI. The study further revealed that usability should be included as a phase in the design and development lifecycle of BI.
    - The study by Beelders and Kotzé (2020) focused on a set of usability criteria from one study, whereas in this dissertation the researcher conducted a narrative literature review (NLR) and a systematic literature review (SLR) to identify a set of LBUC from multiple studies. Beelders and Kotzé's (2020) study confirms the importance of usability and how its implementation can increase the usage and adoption of BI.
- Liu et al. (2023) developed a UX framework that was aimed at helping the design of BI visualisation and promote better decision-making in the business. The study performed the literature survey to gain an understanding of the topic based on previous research work. The study also performed a case study that implemented their BI visualisation framework to validate their framework in the real business world. The study revealed that the BI visualisation framework can promote decision-making performance and customer satisfaction, as well as enhance competitiveness and influence BI development by companies.
    - Compared to this dissertation, the study by Liu et al. (2023) focused on UX. They studied three usability criteria (i.e. efficiency, effectiveness and satisfaction), whereas this dissertation utilised 14 usability criteria. Their study confirms that UX can help the business make better informed decisions, improve satisfaction and influence BI development by companies.
- Nazar et al. (2021) discovered a point of intersection between two fields, namely HCI and Explainable Artificial Intelligence (XAI), which was gained through a literature review. The literature survey encompassed themes identified in the literature (such as XAI and its areas, major XAI aims, and XAI problems and challenges). The study's other major focus was on the use of AI, HCI, and XAI in healthcare. Within HCI, they explored usability and human-centered design (HCD), and within usability they

focused on effectiveness, efficiency, and satisfaction usability criteria. The study revealed the shortcomings in XAI in healthcare, as well as the field's future potential.

  - The study of Nazar et al. (2021) focused on AI specifically while the current study focusses primarily on BI. They studied three usability criteria (i.e. efficiency, effectiveness, and satisfaction), whereas this dissertation utilised 14 usability criteria. Their study further focuses on the healthcare services while the current study focuses on Banking.

- Williams et al. (2022) sought to better understand BI implementation success and failure through the technical, organizational, and process (TOP) model. This work provided insights into developing a decision model to support successful BI implementation. A literature review of empirical studies in BI was conducted to examine research into the process of organizations avoiding failure in BI implementation. From the technical perspective, three main criteria were identified: system quality, information quality, and user satisfaction.
  - Compared to this dissertation, the study by Williams et al. (2022) was on a more abstract level and it did not have the detailed constructs that this dissertation contains.
- Ali et al. (2022) focused on android application's usability using a scenario-based approach by selecting major usability attributes, namely effectiveness, efficiency, satisfaction, learnability, and memorability. Their study focused on variations in People at the centre of Mobile Application Development (PACMAD) attributes based on the participants' education and age. Their results showed that participants under 25 and 25 to 35 have shown more Effectiveness, Efficiency, Satisfaction, Learnability, and Memorability and they have committed fewer Errors and shown less Cognitive Load during usability testing as compared to participants over 35. It is inferred from their study that application usability and acceptability can be increased by considering the general population during development which includes all groups of people based on education and age.
  - The study by Ali et al. (2022) focused on five usability criteria, whereas in this dissertation the researcher had a detailed constructs consisting of 14 usability criteria obtained from NLR and SLR. The study confirms the importance of considering education and age for the usability of the applications.

Section 7.4 presents the limitations of the research.

7.4. Limitations of the Research

This research study was limited in that it was conducted at just one of the SA banks and not all the employees of the bank were included in the study. In addition, only one business unit of the bank was included. Based on the methods used to collect the data, the required number of participants was reasonable for achieving the purpose of this study. Participants included those who had used the BI system previously and no one without a background in BI was interviewed or participated in the survey.

Ninety-eight participants were included in the survey, while 31 were considered for the interviews in order to finalise the CBIBRUCUP that may be used to evaluate the BI banking reports.

As mentioned in Chapter 6, the mapping of the BI issues to usability criteria was done in alignment with the literature definitions of the criteria; however, the practical nature of the issues required certain subjective decisions on the part of the researcher. While effectiveness and efficiency influenced most of the issues, the purpose was to see which of the other criteria were also relevant. Therefore, the CBIBRUCUP are suggested as an empirically based starting point for future research rather than as a final and complete set of criteria.

Section 7.5 discusses the contribution made by the study.

7.5. Contribution of the Study

This research which was conducted with BI banking report users in one of the SA banks, contributes to the existing body of knowledge in the following manner: section 7.5.1 presents the theoretical contribution and section 7.5.2 presents the practical contribution.

7.5.1. Theoretical Contribution

The theoretical contribution of this study includes the extraction and identification of literature-based usability criteria (LBUC) that can be used as a basis for the evaluation of the BI banking reports (initially presented in Chapter 3, section 3.8). The theoretical contribution of the existing body of knowledge includes a list of BI banking reports usability issues that was compiled based on the CIL data extraction (see Table 5.14), as well as a list of BI banking report usability issues as extracted from BI users by means of interviews, together with their respective usability criteria (see Appendix H). Having the usability criteria in the context of banking allows BI banking report developers to develop reports with the users in mind so as to ensure user satisfaction.

7.5.2. Practical Contribution

The practical contribution that this study makes is its evaluation of the usability criteria for BI banking reports in order to determine their appropriateness. Participants were chosen on the basis of being BI users with BI experience who use BI banking reports every day in their work. The results of the study produced critical usability criteria for BI banking reports; this was made possible by triangulating the results of the survey, the CIL data extraction and the interviews, and thus confirming the critical usability criteria. These criteria have proven to be applicable for designing better BI banking reports to improve user satisfaction. Therefore, the triangulation has shown the validity and accuracy of this study.

Section 7.6 makes a number of recommendations for future research.

7.6. Recommendations for Future Research

The findings of the CIL data extraction and the interviews revealed that BI banking report issues exist, while the survey findings did not reveal the presence of such issues. As a result, the CIL data extraction and interviews contradicted the findings of the survey. Therefore, future studies could investigate the contradictions between the CIL data extraction and the interviews as data collection methods and the survey. Future studies could also focus on more than one bank or the entire bank instead of just one business unit and it would be useful to repeat the same study with them. A similar study could also be conducted by employing other data collection techniques such as focus groups and observation.

Artificial Intelligence (AI) has become an increasingly important for business professionals and experts (Adetayo, 2023; Azmi et al., 2023; Tlili et al., 2023); especially after the worldwide COVID-19 pandemic (Azmi et al., 2023). AI is also being more visible in different aspects of our lives, such as ChatGPT (Tlili et al., 2023). The development of AI technology expands the boundary of business practice, inducing the emergence and application of BI that has promoted the transformation of information techniques to optimize business decision and operation (Chen & Lin, 2021). Furthermore, in the field of business, decision-makers use continuously BI to push their business activities and outcomes to an excellent level (Azmi et al., 2023). BI and AI share several common features, amongst others, in that both BI and AI rely on data integration to gather information from multiple data sources and support decision-making processes (Azmi et al., 2023). Although AI is beyond the scope of this study, future studies can consider expanding the current study to include AI or identify the critical usability criteria for AI in the banking industry for informed decision-making.

Section 7.7 presents the researcher's reflection on the study.

7.7. Reflections on the Study

The researcher learnt how crucial it is to show evidence of rigour, credibility, relevance and validity, to ensure that the collected data make sense to the reader and is emblematic of trustworthiness.

This study enlightened the researcher with regard to her ability to conduct research in general. Having to embark on a topic that had no foreseeable outcome was a challenge. But, having embarked on this journey and looking at the work experience gained, this study will assist the researcher in her everyday operational tasks, which include designing architectural landscapes, using the usability criteria experience gained during this study. This study has enabled the researcher to approach her work from the user's perspective and ensure that the user is satisfied when receiving and using the products.

The research seemed simple when this journey started, I thought that in a year I would be done with everything but there were a lot of hurdles along the way. However, with the support of my supervisors and my husband, who provided me with words of encouragement, as well as not giving up on me, this work was all worthwhile. This encouraged me not to give up and to push further to complete the research.

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APPENDIX A: ETHICAL CLEARANCE

UNISA university of south africa

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) ETHICS REVIEW COMMITTEE

2 November 2020

ERC Reference #: 2020/CSET/SOC/031
Name: Pheladi Annah Lebotsa
Student #: 56344589

Dear Miss PA Lebotsa

Decision: Ethics Approval from 2 November 2020 to 1 November 2023 (Humans involved)

Researcher: Miss Pheladi Annah Lebotsa
56344589@mylife.unisa.ac.za, Lebotsa26@gmail.com, 079 789 1893

Supervisors: Prof. Judy van Biljon
vbiljja@unisa.ac.za, 011 670 9182

Mrs Ronell van der Merwe
VDMerwer@unisa.ac.za, 011 471 2929

Working title of research:

Guidelines for the usability of Business Intelligence banking reports: Case study in the South African banking industry

Qualification: MTech in IT

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Ethics Review Committee for the above mentioned research. Ethics approval is granted for 3 years.

*The **low risk application** was expedited by the College of Science, Engineering and Technology's (CSET) Ethics Review Committee on 2 November 2020 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision will be tabled at the next Committee meeting for ratification.*

The proposed research may now commence with the provisions that:

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PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
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1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa COVID-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Science, Engineering and Technology's (CSET) Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
6. 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. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
8. No field work activities may continue after the expiry date 1 November 2023. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.
9. Permission to conduct this research should be obtained from First National Bank prior to commencing field work.

Note

The reference number 2020/CSET/SOC/031 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

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

Yours sincerely,

Mr C Pilkington
Chair of School of Computing Ethics Review Subcommittee
College of Science, Engineering and Technology (CSET)
E-mail: pilkicl@unisa.ac.za
Tel: (011) 471-2130

Prof. E Mnkandla
Director: School of Computing
College of Science Engineering and Technology (CSET)
E-mail: mnkane@unisa.ac.za
Tel: (011) 670 9104

Prof. B Mamba
Executive Dean
College of Science Engineering and Technology (CSET)
E-mail: mambabb@unisa.ac.za
Tel: (011) 670 9230

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
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APPENDIX B: CONSENT TO PARTICIPATE IN THIS STUDY

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CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the <insert specific data collection method>.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname..... (please print)

Participant Signature..... .Date.....

Researcher's Name & Surname Pheladi Lebotsa

Researcher's signature..... Date.....

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Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
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APPENDIX C: SURVEY QUESTIONS AND COVER LETTER

Ethical clearance #: 2020/CSET/SOC/031

COVER LETTER TO AN ONLINE ANONYMOUS WEB-BASED SURVEY

Dear Prospective participant,

You are invited to participate in a survey conducted by Pheladi Annah Lebotsa under the supervision of Judith Arnoldine van Biljon a professor, in the Department of School of Computing towards a MTECH: INF TECHNOLOGY at the University of South Africa.

The survey you have received has been designed to study the identification of the critical BI usability criteria for reports in the banking industry will improve the usage of these reports. You were selected to participate in this survey because you are over the age of 18, and you work for the selected organisation. You will not be eligible to complete the survey if you are younger than 18 years, does not understand English, has never been a business intelligence user and has never used business intelligence OLAP cubes, data mining, catalogues, reports, or dashboards. By completing this survey, you agree that the information you provide may be used for research purposes, including dissemination through peer-reviewed publications and conference proceedings.

It is anticipated that the information we gain from this survey will help us to find the critical usability criteria that should be used to evaluate business intelligence banking reports. You are, however, under no obligation to complete the survey and you can withdraw from the study prior to submitting the survey. The survey is developed to be anonymous, meaning that we will have no way of connecting the information that you provide to you personally. Consequently, you will not be able to withdraw from the study once you have clicked the send button based on the anonymous nature of the survey. If you choose to participate in this survey it will take up no more than 30 minutes of your time. You will not benefit from your participation as an individual, however, it is envisioned that the findings of this study will enable the understanding of BI usability criteria of reports in the context of the South African banking industry, and this criterion can be used to optimise the usage of business intelligence banking reports. We do not foresee that you will experience any negative consequences by completing the survey. The researcher(s) undertake to keep any information provided herein confidential, not to let it out of our possession and to report on the findings from the perspective of the participating group and not from the perspective of an individual.

The records will be kept for five years for audit purposes where after it will be permanently destroyed. You will not be reimbursed or receive any incentives for your participation in the survey.

The research was reviewed and approved by the < identify the Ethics Review Committee>. The primary researcher, Pheladi Annah Lebotsa, can be contacted during office hours at 0797891893 or email lebotsa26@gmail.com. The study leader, Prof Judith Arnoldine van Biljon, can be contacted during office hours at 011 670 9182 or email vbiljja@unisa.ac.za. Should you have any questions regarding the ethical aspects of the study, you can contact the chairperson of the School of Computing Ethics Research Committee, Colin Pilkington at 011 471 2130, SoCethics@unisa.ac.za or pilkicl@unisa.ac.za. Alternatively, you can report any serious unethical behaviour at the University's Toll Free Hotline 0800 86 96 93.

You are making a decision whether or not to participate by continuing to the next page. You are free to withdraw from the study at any time prior to clicking the send button.

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1. Background Questionnaire

1.1. Please indicate your age

18-24	*25-34*	*35-44*	*45 +*	*Prefer not to say*

1.2. Please indicate your gender

Male	Female	Prefer not to say

1.3. What is your home language?

English	Afrikaans	isiZulu	isiXhosa	Setswana	Sesotho	Prefer not to say
Sepedi	siSwati	isiNdebele	Xitsonga	Tshivenda	Other	

If other, please specify ----------

1.4. For how long have you been a business intelligence user?

0-3 months	3-12 months	12-24 months	24-48 months	48+ months

1.5 Do you have experience with any of the following business intelligence areas.

OLAP cubes	Data mining	Catalogs	Reports	Dashboards

1.6. Have you ever used a Business Intelligence system?

Yes	No

2. Survey questions

2.1.	**Learnability**					
2.1.1.	**Predictability**					
	The report produces results in line with the user's commands	Strongly Disagree				Strongly Agree
		1	2	3	4	5

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2.1.2.	**Familiarity**					
	My knowledge of banking reports helped me to use the report	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.1.3.	**Consistency**					
	The report layout is consistent.	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.2.	**Robustness**					
2.2.1.	**Recoverability**					
	It was easy to recover my work from an unexpected situation, e.g. power cut	Strongly Disagree				Strongly Agree
		1	2	3	4	5
	It is easy to take corrective actions (e.g. undo) once the error has been recognised.	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.2.2.	**Responsiveness**					
	The report site provides feedback to indicate continued progress	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.2.3.	**Task Conformance**					
	The report meets all the user's task needs	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.3.	**Design**					
2.3.1.	**Visibility**					
	The report shows the relevant information and functionalities	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.3.2.	**Feedback**					
	The report provides informative responses to the user	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.3.3.	**Mapping**					
	The user's actions lead to expected results	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.4.	**Flexibility**					
2.4.1.	**Customizability**					
	The user is able to customise the report according to their individual priorities	Strongly Disagree				Strongly Agree
		1	2	3	4	5

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2.4.2.	Multi-threading					
	The report site allows the user to view multiple reports at the same time.	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.5.	Usability					
2.5.1.	Effectiveness					
	The report provides the user with the information they require to achieve their goals.	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.5.2.	Efficiency					
	The report aids the user in completing their tasks on time	Strongly Disagree				Strongly Agree
		1	2	3	4	5
2.6.	Satisfaction					
	The user is satisfied after using the report	Strongly Disagree				Strongly Agree
		1	2	3	4	5

Please write any additional comments or elaborations you may have in the space below.

3. Submit

3.1. Would you like to submit your responses?

No - Stop/Withdraw	Yes - Submit

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Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
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APPENDIX D: INTERVIEW

Interviews

Background Questionnaire

1.1. Please indicate your age

18-24	*25-34*	*35-44*	*45 +*

1.2. Please indicate your gender

Male	Female

1.3. What is your home language?

English	Afrikaans	isiZulu	isiXhosa	Setswana	Sesotho
Sepedi	siSwati	isiNdebele	Xitsonga	Tshivenda	Other

If other, please specify ----------

1.4. Have you ever used a Business Intelligence system?

Yes	No

1.5. For how long have you been a business intelligence user?

0-3 months	3-12 months	12-24 months	24-48 months	48+ months

1.6. Do you have experience with any of the following business intelligence areas?

OLAP cubes	Data mining	Catalogs	Reports	Dashboards

1. **Are you satisfied with the BI reports (Yes/No)? Why?**

2. **Interview questions**

	BI banking reports issue **(Which BI Banking Report issue do you associate with?)**	**Answer**
1	The report takes times to load (Yes/No) **Probe 1:** Does this issue reoccur or occur in multiple reports that you use (Frequency) **Probe 2:** What do you believe was done in order to fix the BI report issue you encountered, or you associate with?	
2	Additional of requirements (Yes/No) **Probe 1:** Does this issue reoccur or occur in multiple reports that you use (Frequency) **Probe 2:** What do you believe was done in order to fix the BI report issue you encountered, or you associate with?	
3	Reports user friendliness (users' needs reports that are user friendly) (Yes/No) **Probe 1:** Does this issue reoccur or occur in multiple reports that you use (Frequency) **Probe 2:** What do you believe was done in order to fix the BI report issue you encountered, or you associate with?	
4	Clear understanding of the report (Yes/No) **Probe 1:** Does this issue reoccur or occur in multiple reports that you use (Frequency)	

	Probe 2: What do you believe was done in order to fix the BI report issue you encountered, or you associate with?	
5	Inconsistency of the data (e.g., null values) (Yes/No) **Probe 1:** Does this issue reoccur or occur in multiple reports that you use (Frequency) **Probe 2:** What do you believe was done in order to fix the BI report issue you encountered, or you associate with?	
6	Misalignment of reporting (Yes/No) **Probe 1:** Does this issue reoccur or occur in multiple reports that you use (Frequency) **Probe 2:** What do you believe was done in order to fix the BI report issue you encountered, or you associate with?	
7	Up to date reporting (Reports are not up to date) (Yes/No) **Probe 1:** Does this issue reoccur or occur in multiple reports that you use (Frequency) **Probe 2:** What do you believe was done in order to fix the BI report issue you encountered, or you associate with?	
8	Misalignment of reporting due to incorrect business rules (Yes/No) **Probe 1:** Does this issue reoccur or occur in multiple reports that you use (Frequency)	

	Probe 2: What do you believe was done in order to fix the BI report issue you encountered, or you associate with?	
9	Inaccessibility of reports (Yes/No) **Probe 1:** Does this issue reoccur or occur in multiple reports that you use (Frequency) **Probe 2:** What do you believe was done in order to fix the BI report issue you encountered, or you associate with?	
10	Back-end and front-end misalignment (Yes/No) **Probe 1:** Does this issue reoccur or occur in multiple reports that you use (Frequency) **Probe 2:** What do you believe was done in order to fix the BI report issue you encountered, or you associate with?	

3. **Are there any other BI report issues that you had an encounter with while using the BI reports?**

4. **On a scale of 1 to 5 are you satisfied with the BI reports**

APPENDIX E: CIL PROJECT CODE AND CODE DESCRIPTIONS

No	Code	Code description	BI report(R), BI issue (I)
1	Adequacy/activation daily tracker	This is a code for a report. The report in which the request has been logged to get it resolved.	R
2	Product 1 Daily File	This is a code for a report. The report in which the request has been logged to get it resolved.	R
3	MyBI	This is a reporting portal where reports are being hosted for users to access their reports in a central location	R
4	Missing Data	This code refers to the data that is missing on the reports. This data may be missing for a particular period and may require to be refreshed for the report to be updated.	I
5	Upgrades Report	This is a report, in which multiple requests were logged against it because there was data missing or the report was not updated for the given time frame	R
6	Reclassification Sales Report	This is a report in which the sales are being tracked on a daily.	R
7	Product 2 Accounts report	Is a report code, where they are tracking accounts for a certain product	R
8	System Issues	Refers to a system problem which needs to be resolved.	I

No	Code	Code description	BI report(R), BI issue (I)
9	Product 5 sales Analysis Report	This is a report that track a certain product	R
10	Report Investigation	This means that a gap analysis is required to ensure that the solution is correct or aligned with other solutions with similar KPIs	I
11	Enhancement of Reports	Means that the business had requirements previously and want to change some of the previous requirements, thereby enhancing the report.	I
12	Product 3 Report	This is a report that is specific to a certain product	R
13	Account Fast-track Report	This is a report that track a product that are sold to customers	R
14	Team 2 Monthly Pack Report	It's a monthly pack which is made up of a lot of other reports	R
15	Opportunity or Missed report	This is a report that track whether customers who qualify for credit products had offered them when they opened an account	R
16	Product 3 and product 4 report	This is a report that track a certain product. The report needs to track if the customers that hold the other product hold the other one or not	R
17	MFT Feed	A secure file share in which files can be transferred by different parties within a	R

No	Code	Code description	BI report(R), BI issue (I)
		location that has been setup which aligns to security protocols in place	
18	Sales Report	This is a report that track sales	R
19	Data source	The data sources used in the back end of the reports	I
20	Sales Quality report	This is a report that track quality of accounts sold	R
21	Data Request	Contains the requests in which data was requested. This was supposed to be in the data extract request type, however when the client requested these, they allocated an incorrect request type.	I
22	Product 7 Sales Report	This is a report that track a certain product that are sold to customers	R
23	New Branch details Report	Report that contains branch information	R
24	Campaign Management Report	This is a report that track campaigns performance	R
25	3rd Party reporting	This is a report that track products sold by an external party	R
26	Campaign offers	Refers to product offers that are offered to customers/ or the product that the customer holds	N/A
27	Campaign offers Report	This is a report that track offers that have been offered to customers	R
28	Daily Sales Report	This is a report that track daily sales	R

No	Code	Code description	BI report(R), BI issue (I)
29	Access to reports	This is when the customer doesn't have access to reports when they try to view them. This can be due to a system issue, e.g., report is down and inaccessible	I
30	Enterprise Value Vintage report	A report that tracks the employee performance	R
31	Slow speed	This means that the response time of the report or report portal is slow	I
32	Data quality issues	This refers to when there are issues with the data on the reports that the client is accessing, e.g., they get values that they didn't expect on certain fields, for example a null value.	I
33	BankServ Report	This is a report that track transactions that occurred.	R
34	Visa Report	This is a report that track a particular card type	R
35	Team 1 Recon report	This is a report that track products the overall movement of reports. In this report there are many other sub reports	R
36	Card Base Report	This is a report that track number of cards	R
37	Manual Excel Report	This is a manual report	R
38	Enterprise Value Sales & lifestyle sales report	This is a report that track the sales of different products offered to customers	R

No	Code	Code description	BI report(R), BI issue (I)
39	Product 15 main account	Contains the main account holders for a particular product	R
40	Product 9 secondary sales report	Data extract of the secondary sales of a particular product	R
41	Sales Analysis Fast-track	This is a report that track sales	R
42	Delivery Tool Report	This is a report that track the delivery of customer products	R
43	Opened Accounts	Accounts that are opened at a particular time. This code is used for both a report and a function.	R
44	Card Issuance	Contains the cards that were issued	R
45	Sales cube	It's a report that tracks the sales of accounts	R
46	Call Centre performance report	This is a report that track the performance of the call centre	R
47	Reclassification Report	This is a report contains sales as well as open classification	R
48	Sales Daily War Room Report	This is a report that track sales	R
49	Team overview Report	This is a report that tracks the performance of the employees	R
50	Regional Manager Report	This is a report that track the regional managers for the different branches	R

No	Code	Code description	BI report(R), BI issue (I)
51	Product 16 Cross-Sell Campaign	This is a campaign for a particular product	R
52	Reclassification Open Report	This is a report in which the opened accounts are being tracked on a daily.	R
53	Product 9 Report	This is a report that track performance of a type of product	R
54	Sales and Sales Distribution Report	A report that tracks credit offers that the customers took	R
55	Reclassification sales	This is a report in which the active accounts are being tracked on a daily.	R
56	SIMS	This is used to track sales	R
57	Sales Transactional Report	This is a report that track different KPIs	R
58	Transactional Cheque account	Contains data extract for the transactional cheque account for a particular region	R
59	Full Decay Report	This is a report that track full decay of different products	R
60	Product 8 Missed sales report	This is a report that track the missed sales for a type of product	R
61	Product 7 Sales Report	This is a report that track a certain product that are sold to customers	R
62	Harambee_Dialstring Report	This is a report that track performance for Harambee dialstring	R

No	Code	Code description	BI report(R), BI issue (I)
63	Harambee Tracking Report	This is a report that track for Harambee sales	R
64	Daily Switch Report	This is a report that track daily switches	R
65	Team 4 v10 File	File that tracks the sales for team 4	R
66	Daily KPI report	This is a report that track different KPIs.	R
67	System Constraints	Refers to the situation where the system is using a lot of resources which in turn has a negative impact on the performance.	I
68	VSI report	Contains vendor's singe interest report.	R
69	Data extraction	Refers to when the client requires data as an extract for reporting purposes.	R
70	Sales Flat file	It's a daily file that tracks the sales.	R
71	VIP delivery file	This is a daily file that tracks the delivery file.	R
72	Salary and Debit order Switch report	A report that tracks salary and debit order switching.	R
73	On-boarding report	A report that tracks the onboarding of customers.	R
74	Summary view report	This is a summary view of a report.	R
75	Product 9 sales	Sales for a particular product.	R

APPENDIX F: THE SURVEY DEMOGRAPHIC INFORMATION

Gender	**Frequency**	**Percentage**
Male	58	59.2
Female	40	40.8
Total	98	100.0
Age		
18 – 24 months	2	2.0
25 – 34 months	62	63.3
35 – 44 months	28	28.6
45 and above	5	5.1
Prefer not to say	1	1.0
Total	98	100.0
Language		
Afrikaans	6	6.1
English	27	27.6
isiNdebele	1	1.0
isiXhosa	10	10.2
isiZulu	14	14.3
Sepedi	6	6.1
Sesotho	12	12.2
Setswana	12	12.2
siSwati	2	2.0

Xitsonga	7	7.1
Prefer not to say	1	1.0
Total	98	100.0
BI user		
0-3 months	10	10.2
13-24 months	17	17.3
25-48 months	21	21.4
4-12 months	5	5.1
49 and above months	45	45.9
Total	98	100.0
Business Intelligence Areas		
Dashboards	9	9.2
Data mining, Catalogues, Reports	1	1.0
Data mining, Dashboards	1	1,0
Data mining, Reports	2	2.0
Data mining, Reports, Dashboards	6	6.1
Data mining	1	1.0
Data mining OLAP cubes, Reports	1	1.0
Data mining, Reports, Dashboards	4	4.1
Data mining, Reports, Dashboards, Catalogues	4	4.1

OLAP cubes, Data mining, Reports, Dashboards	4	4.1
OLAP cubes, Reports, Dashboards	5	5.1
OLAP cubes, Catalogues, Reports, Dashboards	2	2.0
OLAP cubes, Data mining, Catalogues, Reports, Dashboards	8	8.2
OLAP cubes, Reports, Dashboards, Data mining	1	1.0
Reports	7	7.1
Reports, Dashboards	38	38.8
Reports, Dashboards, Catalogues;	4	4.1
Total	98	100.0
BI system user		
Maybe	13	13.3
No	7	7.1
Yes	78	79.6
Total	98	100.0

APPENDIX G: INTERVIEW CODE AND CODE DESCRIPTIONS

No	Code	Description
1	Bad connectivity	This relates to the problem with the way the connection was setup.
2	BI system capacity	This relates to the maximum of the BI systems per usage numbers of times.
3	Customer requirements	These are the requirements required or requested by the stakeholder.
4	Data cleaning	This is the process used to cleanse the data.
5	Data Configuration	This relates to the environment setup of the tools.
6	Data loading	This refers to loading the data into the tables or data sources for consumption
7	Data Optimization	This relates to when the data prepared for efficiency, like ensuring that the queries do not run for a long time.
8	Data source	This is often used interchangeably with a table. It relates where the data is stored.
9	Data volume	This relates to the amount of data that is stored, like in a data source, or required for reporting
10	Error resolution	This refers to the error that may have been encountered on the report for example during data loading
11	Loading time	This refers to the time it takes to load the data from the source
12	Monitoring system	This is used to monitor the ETL jobs and ensure that every job has ran successfully and those that failed are remediated
13	Report Availability	This is when the report is made for consumption.
14	Report testing	This refers to the ability to test the report by the stakeholders
15	System performance	The ability for the system to be efficient enough to process any queries
16	Business rules changes	Business rules are predefined rules/conditions that aim to standardize an organization’s workflow and reduce errors.

No	Code	Description
		Business rules are transformations that the stakeholder changes.
17	Department collaboration	This relates to the different stakeholders that needs to come together and collaborate to deliver on the relevant tasks or initiatives
18	Dynamic reports	This refers to the report that is flexible and allows for self-service from the stakeholder, e.g., the ability to change what they need instead of waiting for anyone
19	Report design issue	The way the report is created, like did they include filters that can be used to slide and dice, is the report visible and is it understandable.
20	Report visualization	This relates to when the user can view the data in a way that is easier for them.
21	Data quality	This relates to the state of data, which is being used on stored, for example is the data of high quality, can it be trusted.
22	How to guide / navigation	This refers to the ability to provide the overall descriptions of the reports so that when users who are not familiar with the report, they can be able to self-service
23	Report understanding	Refers to when the user does not understand the report and requires support to do so.
24	Skilled team	This refers to the skills that each team member possesses to perform their duties
25	Unresolved issues	This refers to any BI banking report issues that may have not been resolved
26	Familiarity with the report	This refers to the ability for the stakeholder to go through the reports, analyses it and explore to familiarize themselves with the report
27	Business rules standards	Set of rules that govern the business rules.
28	Data availability	This is when the data is made for consumption.
29	Data tool investment	There are multiple data tools available in the market, this refers to the organization investing in the tools they teams require for data

No	Code	Description
30	Job failure	This refers to when the ETL job that is used to load the data from the source to the target fails. This failure may be caused by multiple reasons such us bad connectivity
31	Data inconsistency	This relates to when there are different versions of the same data that is stored or being used
32	Report Access	This refers to the access management of the reports to ensure that it is granted to those who are using the report due to POPIA.
33	Business rule owner	Contains the subject matter expect for the business rule.
34	Incorrect business rules	This refers to the transformation rules that were incorrect
35	Data protection	This relates to the protection of data from unauthorized user.

APPENDIX H: INTERVIEW CODE AND RESPECTIVE BIBRUC AND BIBRUCUP

No	Code	Refined Usability criteria
1	Bad connectivity	Responsiveness and effectiveness
2	BI system capacity	Multi-threading
3	Data cleaning	Mapping
4	Data Configuration	Responsiveness & Recoverability
5	Data loading	Responsiveness & Efficiency
6	Data Optimization	Responsiveness
7	Data volume	Responsiveness & Efficiency
8	Error resolution	Responsiveness
9	Loading time	Responsiveness & Efficiency
10	Monitoring system	Recoverability & Feedback
11	Report Availability	Effectiveness & Consistency
12	Report testing	Effectiveness
13	System performance	Responsiveness & effectiveness
14	Data source	Mapping
15	Customer requirements	Effectiveness
16	Dynamic Reports	Customisability
17	Report visualization	Visibility
18	Report design issue	Efficiency & visibility
19	Business rules changes	Effectiveness
20	Department collaboration	Effectiveness & Familiarity
21	Data quality	Mapping & Effectiveness
22	How to guide / navigation	Task conformance & familiarity
23	Report understanding	Familiarity & task conformance
24	Skilled team	Efficiency & Effectiveness
25	Unresolved issues	Efficiency & Effectiveness
26	Familiarity with the report	Familiarity & task conformance
27	Business rules standards	Consistency
28	Data availability	Effectiveness
29	Data tool investment	Effectiveness
30	Job failure	Mapping
31	Data inconsistency	Consistency
32	Report Access	Effectiveness

No	Code	Refined Usability criteria
33	Business rule owner	Consistency
34	Incorrect business rules	Consistency
35	Data protection	Effectiveness

APPENDIX I: PUBLICATION RESULTING FROM THIS STUDY (to be submitted)

Article title: USABILITY GUIDELINES FOR BUSINESS INTELLIGENCE REPORTS IN THE SOUTH AFRICAN BANKING INDUSTRY

Pheladi Lebotsa	Judy van Biljon	Ronell van der Merwer
56344589@mylife.unisa.ac.za	vbiljja@unisa.ac.za	vdmerwer@unisa.ac.za

ABSTRACT

The South African banking sector is renowned as world-class, boasting ample capital, cutting-edge technology, robust infrastructure, and a rigorous regulatory and supervisory framework. Using Business Intelligence Systems is fundamental to providing the -driven decision support needed to keep the banking industry competitive. The problem is that many Business intelligence reports are not used optimally, and in some cases not used at all, due to usability problems. The aim of the study is report on an investigation into BI usability criteria and to propose evidence-based usability guidelines for business intelligence reports in the banking industry. A mixed-methods research design, guided by a pragmatist philosophy was employed. First by extracting usability requirements for BI systems were extracted from literature. The core usability constructs identified formed that basis of a survey with employees at a South African Bank. The bank keeps a Company issues log (CIL) on BI reports, that was analysed to investigate the mapping between the reported issues and usability requirements for BI systems. Interviews were further performed to validate the results from survey and CIL data extraction. According to the survey, no BI banking usability issues were identified, however the analysis of the CIL data extraction and interviews revealed BI banking reports usability issues. The triangulation of the findings from the survey, CIL data extraction analysis and the interviews revealed discrepancies which were used to refine the initial set of usability criteria to provide the critical usability criteria for the BI banking context.

Contribution: The main contribution to the knowledge domain is the evidence-based usability criteria for BI banking reports.

Keywords – Business intelligence, BI, usability, usability criteria, South African banks.

INTRODUCTION

South African (SA) banks rank among the largest banking corporations on the African continent (Smith, 2021). The SA banking sector is renowned as world-class, boasting ample capital, cutting-edge technology, robust infrastructure, and a rigorous regulatory and supervisory framework (Matemilola et al., 2015). The prominent banks in SA encompass the Amalgamated Banks of South Africa (ABSA), Standard Bank Group, Nedbank Group, and FirstRand Bank (Ramavhona & Mokwena, 2016). The provision of banking services in the

South African region holds significant importance, catering to a diverse range of needs for businesses, consumers, and investors (Smith, 2021).

Informed decision-making within the banking sector necessitates Business Intelligence (BI), which facilitates the transformation of data into actionable insights, instrumental in making astute business choices (Hočevar & Jaklič, 2010). BI empowers companies to fathom their inherent nature, operational efficiency, and assists in formulating a strategy harmonious with their organizational context, ensuring that implementation paves the way for sound decisions that enhance overall performance (Nithya & Kiruthika, 2021).

BI projects encompass the implementation of BI solutions, involving the design, development, and deployment of Business Intelligence systems (BIS) tailored to an organization's needs. However, a significant percentage of BI projects fail (Ain et al., 2019). Notably, between 60% and 70% of BI projects fail (Olszak, 2016). Isik et al. (2011) suggest that these failures occur when organizations decide to adopt BI without a clear understanding of the critical capabilities that define the success of such applications. The failures of BI projects indicate that organizations encounter challenges beyond straightforward software and hardware implementations since these projects are intricate to deploy and manage (Lautenbach & Johnston, 2017).

The primary reason for the failure of BI projects is the lack of user adoption (Manuel et al., 2017). The adoption and usage of BI depend on a network of interconnected factors, with usability being a pivotal one. Usability significantly influences the acceptance of a BIS by ensuring ease of use and learning (Thowfeek & Salam, 2014). Furthermore, usability plays a crucial role in interacting with user interfaces, enabling users to access information and generate outputs (Shitkova et al., 2015).

The article is presented in four parts. The first part provides the background to the investigation undertaken into the available literature on BI and usability. The research design is then discussed, followed by the presentation of the findings. The article concludes by discussing the findings. This study addresses that gap by considering the following research questions:

a) Main Research Question

What are the critical usability criteria that should be used to evaluate the BI banking reports?

b) Research Sub Questions (RSQ)

i. What criteria are available to evaluate the usability of BI reports?

ii. What are the usability issues of BI reports in the banking industry?

iii. What are the usability criteria that should be used to evaluate the BI banking reports from the user's perspective?

iv. What are the critical usability criteria that should be used to evaluate the BI banking reports from the user's perspective?

LITERATURE REVIEW

The aim of the literature review is to provide background on to offer conceptual clarification of the key concepts and theoretical frameworks underpinning this study. The next section will discuss BI Systems and that will be followed by a section on the usability of BI systems.

BI systems

Munoz (2017) propose two perspectives on BI, the first, viewing BI as a broad perspective which encompass all data-gathering initiatives of an enterprise. The second, entails only the information technology angle relating to software services. Many authors use the terms BI and BIS interchangeably, so it is not always possible to disambiguate their perspectives. In this article the term BI refers to the broad perspective where the goal is improving the timeliness and quality of the business-related information. The term BIS will be used when referring only to the information technology perspective.

Within the realm of BI, there exist several distinct processes, concepts and components that collectively enhance an organization's decision-making capabilities. To elucidate their interrelations, consider Figure 1, which shows sub-themes within processes, concepts, and components. Processes are a crucial component of BI, therefore, there must be processes for storing data in the data warehouse (DW), loading data, be it real-time or historical, by filtering out irrelevant information, and depicting analysis by maintaining metadata (Wixom & Watson, 2010). There are four key concepts of BI namely, data collection (which involves extraction of data and consolidating the data into the DW), analysis (which involves accessing and analysing data), visualization (which involves the creation of reports and dashboards), and decision-making (Xlogiatech, 2023). The components of BI are essential for virtually facilitation decision-making (Bharadiya, 2023). Key components of BI include DW, data sources, data mining, extract, transform and load (ETL), and online analytical processing (OLAP) (Wixom & Watson, 2010).

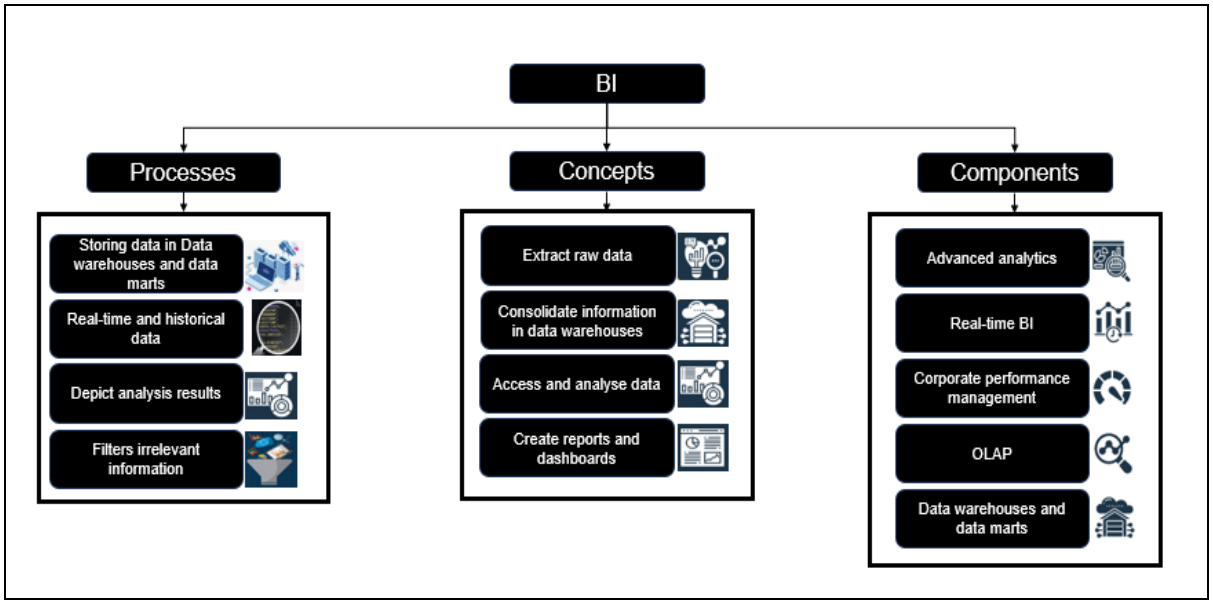

Figure 2: BI processes, concepts, and components (Created by Author)

There are different ways a user can access the data from the DW, such as through OLAP, reports, dashboards, data mining, catalogues, etc. BI reports play a pivotal role in organisations (Tavera Romero et al., 2021). Organizations employ reports to discern performance trends and financial anomalies (Wise, 2012). To maintain competitiveness, interactive reports with drill-through capabilities and dashboard visualizations are essential (Wise, 2012). BI dashboards, a subset of BI tools, offer a mechanism for business owners and executives to explore data through visual interfaces (Quamar et al., 2020). These dashboards condense performance metrics into easily digestible visualizations (Hansoti, 2010). For instance, utilizing OLAP, data is presented in data cubes, fostering quick analysis by transforming raw data into a comprehensible format (Jinpon et al., 2011). Figure 2 shows the BI front-end access point, which is used by the users to access data, in different forms. This view includes the reporting, dashboard and OLAP components. The next section introduces the usability aspect of BI systems.

Figure 3: Front-end BI access point (Created by Author)

Usability of BI systems

Usability means ensuring that interactive products are easy to learn, effective to use, and enjoyable from the user's perspective (Preece et al., 2002). Usability is about users using the system and expressing how they feel about using the system (Hussain et al., 2015). According to the ISO 9241-11 definition, usability is ''the extent to which specified users can use a product to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use'' (ISO 9241-11, 2018; Tullis & Albert, 2008, p. 4). This study adopts the above definition by ISO 9241-11 (2018) and Tullis and Albert (2008) which highlights the three main characteristics of usability as follows: a user is involved, the user is doing something, and the user is doing something with a product or system.

Towards identifying the relevant usability criteria, this study adopted a narrative literature review (NLR), and a systematic literature review (SLR). A NLR is a qualitative method applying traditional reviews of existing and past academic papers towards understanding concept relationships (Yang & Tate, 2012). A SLR is a systematic examination of the scholarly literature about the research topic that critically analyses, evaluates, and synthesises research findings, theories, and practices by scholars and researchers related to an area of focus (Efron & Ravid, 2018).

The NLR produced thirty-five usability criteria resulting from which I twelve were selected based on their relevance to the study's goals. The SLR was conducted during 2019 with the following selection criteria: papers published from 2010 to 2019, selected from the Association for Computing Machinery (ACM), Institute of Electrical and Electronics Engineers (IEEE), and Scopus database engines. In a bid to maintain coherence and consistency across the

selection process, the initial database query used the search string: "usability criteria" AND "business intelligence". Figure 3 depicts the selection process, providing a visualization of the steps undertaken to refine and select pertinent sources. This search yielded a total of five sources from IEEE, two from ACM, and nine from Scopus. The combination of these sources resulted in a pool of sixteen research papers. Subsequent analysis led to the exclusion of one source because the format was not consistent with that of a research paper, three due to duplicates and lastly three articles were further removed from consideration as they did not have the keywords 'usability criteria' in either their title, keywords, and full text. The remaining nine articles were retained for full analysis towards identifying BI usability criteria.

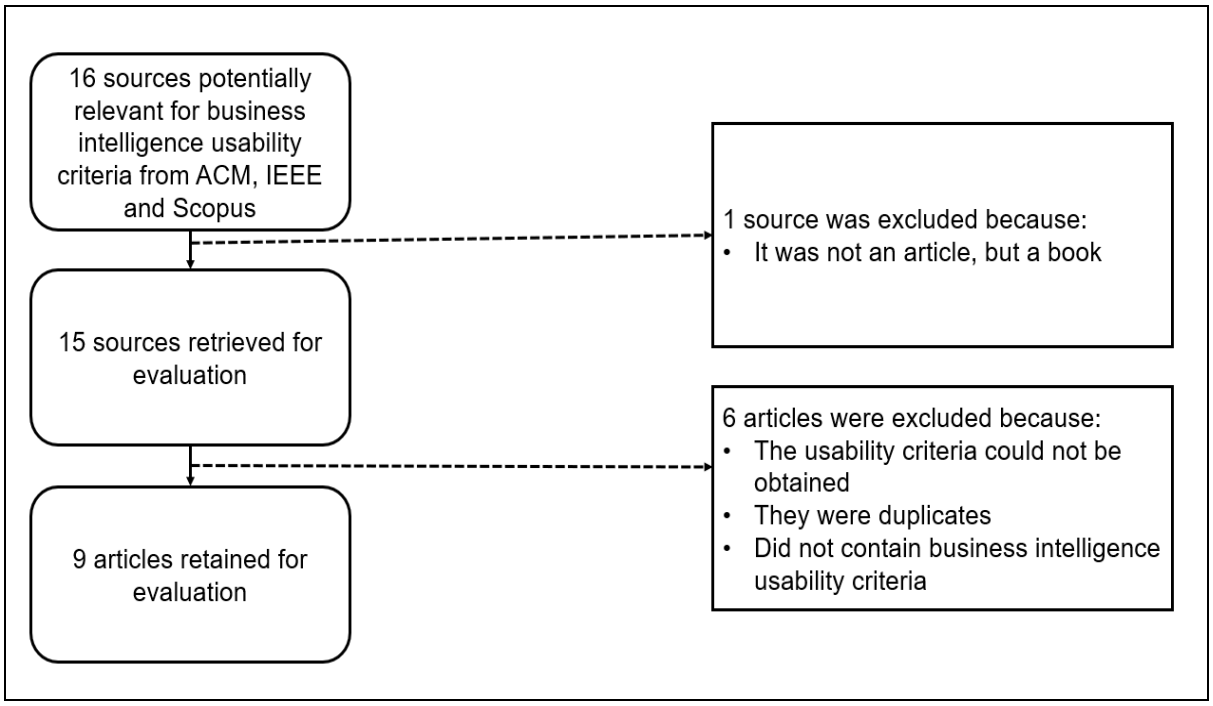

Figure 4: Selection Process for Business Intelligence Usability Criteria (Created by Author)

The SLR yielded a list of twenty usability criteria from which six were selected based on their relevance for this study. The NLR usability criteria and SLR usability criteria were merged to create a list of 14 literature-based usability criteria (LBUC) (see Table 1). The LBUC serve as the foundation of the usability criteria for this study and was further refined throughout the findings of the survey, document analysis and interviews.

Table 2: Literature Based Usability Criteria (LBUC)

No	Category	Usability criteria	NLR & SLR Indicator	Abstracted reference
1	Learnability	Predictability	NLR	Rogers et al. (2012), and Brosens et al. (2018)
2	Learnability	Familiarity	NLR	Rogers et al. (2012), and Brosens et al. (2018)
3	Learnability	Consistency	NLR & SLR	Rogers et al. (2012), and Brosens et al. (2018)
4	Flexibility	Multi-threading	NLR	Rogers et al. (2012), and Brosens et al. (2018)
5	Flexibility	Customisability	NLR	Rogers et al. (2012), and Brosens et al. (2018)
6	Robustness	Recoverability	NLR & SLR	Rogers et al. (2012), and Brosens et al. (2018)
7	Robustness	Responsiveness	NLR	Rogers et al. (2012), and Brosens et al. (2018)
8	Robustness	Task conformance	NLR	Rogers et al. (2012), and Brosens et al. (2018)
9	Usability goals	Effectiveness	NLR & SLR	ISO 9241-11 (2018), and Rogers et al. (2012)
10	Usability goals	Efficiency	NLR & SLR	ISO 9241-11 (2018), and Rogers et al. (2012)
11	Usability goals	Satisfaction	NLR	ISO 9241-11 (2018), and Rogers et al. (2012)

No	Category	Usability criteria	NLR & SLR Indicator	Abstracted reference
12	Usability design principles	Visibility	SLR	Smuts et al. (2015) and Jooste et al. (2014)
13	Usability design principles	Feedback	NLR	Rogers et al. (2012), Norman (1990) and Nielsen (1993)
14	Usability design principles	Mapping	SLR	Smuts et al. (2015) and Jooste et al. (2014)

The next section presents the research method and research design adopted for this study.

RESEARCH DESIGN

The research was conducted at one of the big four banks in South Africa. The participants were bank employees who have experience in BI Banking reports, either creating reports or consuming the reports. Ethical clearance for this study was obtained from the Ethics and Research Committee at the University of South Africa as well as the South African bank at which this study was conducted at.

This study employed Mixed Methods Research (MMR) to evaluate the usability of BI banking reports. The MMR was adopted based on Cameron (2010) and Creswell and Plano's (2011) five Ps framework (Paradigms, Pragmatism, Praxis, Proficiency, and Publishing), which include philosophical considerations and approaches, as well as methodological choices and processes, competencies, practicalities, and political considerations (Cameron, 2010). The overview of the five Ps is provided below:

Paradigms:

A pragmatic approach was adopted for this study, to guides the subject of the research, the activity of the research, and the nature of the research outputs as advocated by (Pickard, 2013). This approach was used to investigate and identify the critical usability criteria that should be used to evaluate business intelligence banking reports.

Pragmatism:

Pragmatism concerns action, change, and the interplay between knowledge and action (Goldkuhl, 2012). It is a method for attaining clarity of ideas within a normative conception of logic, within the norms for continuing, self-correcting inquiry directed towards truth (Baran & Jones, 2016; Goldkuhl, 2012). A major underpinning of pragmatism as philosophy is that knowledge and reality are based on beliefs and habits that are socially constructed (Kaushik & Walsh, 2019; Shannon-Baker, 2015). This study gathers insights from the participants creating or using the BI reports for their operational and strategic work. As a result, the philosophical assumption underlying this study was that of pragmatism.

Praxis:

According to Creswell (2010), Praxis refers to the adoption and use of mixed methods. Mixed methods involve combining or integrating qualitative and quantitative research and data in a research study (Creswell, 2014). Nastasi, Hitchcock, and Brown (2010) suggest integrating MMR research designs and research design typologies, thereby identifying themes that reflect an integrated perspective about “precursors and basic design criteria: types of methods/data mixed, the timing of mixing, breadth of mixing, rationale for mixing, and researcher orientation.”

Multiple designs exist, such as convergent parallel mixed methods, explanatory sequential mixed methods, and exploratory sequential mixed methods (Creswell, 2014). The method suited for this study was explanatory sequential mixed methods because the researcher first conducted quantitative research, analysed the results, and then built on the results to explain them in more detail with qualitative research (Creswell, 2014).

Data Analysis – Statistical Analysis of Survey data

Statistics is the field of study whose objective is to transform data into information (Heiberger & Holland, 2013; York, 2020), that helps us make decisions (York, 2020). Statistical analysis was used to analyse the data collected using the survey. There are different types of statistical analysis, however for the purpose of this study, descriptive statistical analysis and correlation was used. Descriptive statistics are reported numerically in the manuscript text and/or in its tables or graphically in its figures (Vetter, 2017). The descriptive analysis for this study was reported in a table, which contains the number of participants, the minimum, maximum, mean and the standard deviation (see Table 3). In this regard, graphs and tables were created using the Statistical Package of Social Science (SPSS). For this study, the correlation was aimed at quantifying the degree to which two constructs are related (see Table 4). A Pearson product-moment correlation was used to quantify the correlation between the constructs. A Pearson

correlation measures a linear association between 2 normally distributed random variables (Schober & Schwarte, 2018).

Data Analysis – Thematic Analysis (TA) of Company Issues Log (CIL) Data Extraction and Interviews

Thematic analysis (TA) was used to analyse the data collected from CIL data extraction and interviews. TA is a qualitative research method for describing data and involves interpretation in selecting codes and constructing themes (Braun & Clarke, 2006, 2021; Kiger & Varpio, 2020). TA approaches typically acknowledge the potential for inductive (data-driven) and deductive (theory-driven) orientations to coding, capturing semantic (explicit or overt) and latent (implicit, underlying, not necessarily unconscious) meanings, processes of coding, and theme development, and the potential for some flexibility around the theory that frames the research (Braun & Clarke, 2021; Kiger & Varpio, 2020). There are six phases of analysis when using TA, as depicted in Table 2 as suggested by Braun and Clarke (2006).

Table 3: Doing thematic analysis step by step guide (Braun & Clarke, 2006)

No	Phases	Phase description
1	Phase 1: Familiarising with your Data	In this phase the researchers needed to familiarise themselves with the data.
2	Phase 2: Generating Initial Codes	The second phase involved generating initial codes based on the CIL data. This phase involved reviewing the data from the documents, line item at a time and creating initial codes using specific words or text strings from the documents. The researcher used an inductive coding approach to create the codes.
3	Phase 3: Searching for Themes	The third phase involved searching for themes and engaging with the initial codes (from the second phase) by collating all related, relevant data extracts as advocated by van Biljon and Mwapwele (2023). The researcher used a deductive coding approach to create the themes.
4	Phase 4: Reviewing Themes	The fourth phase focuses on refining the code groups, with each being assessed for internal homogeneity and external heterogeneity as advocated by (Braun & Clarke, 2006). In this phase the researcher reviewed the allocated codes as well as the code groups. The researcher also revisited the codes allocated to each

No	Phases	Phase description
		code group and ensured that the relevant codes are allocated to the correct code groups.
5	Phase 5: Defining and Naming Themes	The fifth phase involved defining and naming themes obtained during phase four as advocated by Braun and Clarke (2006) and Scharp and Sanders (2019). In this phase the thinking behind the code groups were reconsidered and based on Phase 1, around the data capturing and familiarisation.
6	Phase 6: Producing the Report	The sixth phase involved producing the research report – a complete data-based story to allow the reader to understand the merit and validity of the analysis.

Data collection and capturing

The research method included a survey, secondary data (extracted from the CIL) and interviews. CIL is a portal that is used by stakeholders to log requests relating to BI reports, reports portals, or database issues experienced by employees while doing their work at the bank. The sample population was obtained from the business unit's central email address, which consists of all the employees who work at a specific business unit of the South African bank as approved by the bank management. which the researcher was able to obtain the ethical clearance to perform the study at.

a) Survey

This survey consisted of Sections A and B. Section A comprises the participant's demographic information. Some critical demographic variables include age, gender and job experience. Section B contained questions relevant to the LBUC of this study. The questions relevant to gathering information about the LBUC was in the form of closed-ended questions. All participants rated each question using a five-point Likert scale, that is an ordinal scale ranging from "strongly disagree" to "strongly agree" (Brooke, 2013). The measurement items (LBUC) used in the survey are developed due to NLR and SLR explorations. Participants were contacted via a central email address with the survey questionnaire link. The central email address contained 274. The survey data was gathered using Google Forms.

b) CIL data extraction

The banking institution has a team that develops and maintains the BI banking reports to ensure that the reports are updated and resolve issues as they arise. This team uses a portal, referred to as the CIL data extraction in this study, to capture issues relating to the BI banking

reports. This CIL data was retrieved from June 2020 to March 2021 and the data was then formatted using an MS word document to prepare for analysis. Thematic analysis (TA) was used to code the participants' feedback as advocated by Braun and Clarke (2006).

c) Interviews

Interviews were held to obtain the participants' feedback about the BI banking reports usability issues. The responses were recorded with transcription (offering from MS Teams), and the researcher also transcribed the recording by re-listening to the recording and formatting the transcription using MS Word. The interview had three sections; Section A is intended to capture the demographic information and a binary question regarding the participants' satisfaction with the BI banking reports. Section B contains the semi-structured interviews questions regarding the BI banking issues identified from the CIL data extraction findings and survey. Section C of the interview used a Likert rating scale 1 to 5 to identify if the participants were satisfied with the BI banking reports. Due to the COVID-19 regulations, the interviews were conducted via Microsoft Teams. The interviewees were selected randomly using the central email address while ensuring that those interviewees were not known personally.

RESULTS AND FINDINGS

The findings, for the survey, CIL data extraction and interviews will be presented in this section.

a) Survey results

This section presents the survey results that were analysed to evaluate the critical usability criteria against the LBUC identified in Table 1. A total of 274 questionnaires were distributed, of which 98 were returned. Those included 58 males (59.2%) and 40 females (40.8%) of the sample. Most of the participants (63.3%) fell into the age group of 25-34 years, followed by the 35-44 years age group (28.6%), and followed by the 45 and above years accounted for 5.1%, and those between 18-24 years accounted for 2% while 1% of the population preferred not to disclose their age.

Figure 4 depicts the participants' experience with BI. Most of the participants (45.9%) have been a BI user for 49 and above months, followed by 25-48 months as a BI user (21.4%), followed by 13-24 months as a BI user (17.3%), followed by 0-3 months as a BI user (10.2%), and lastly followed by 4-12 months as a BI user (5.1%).

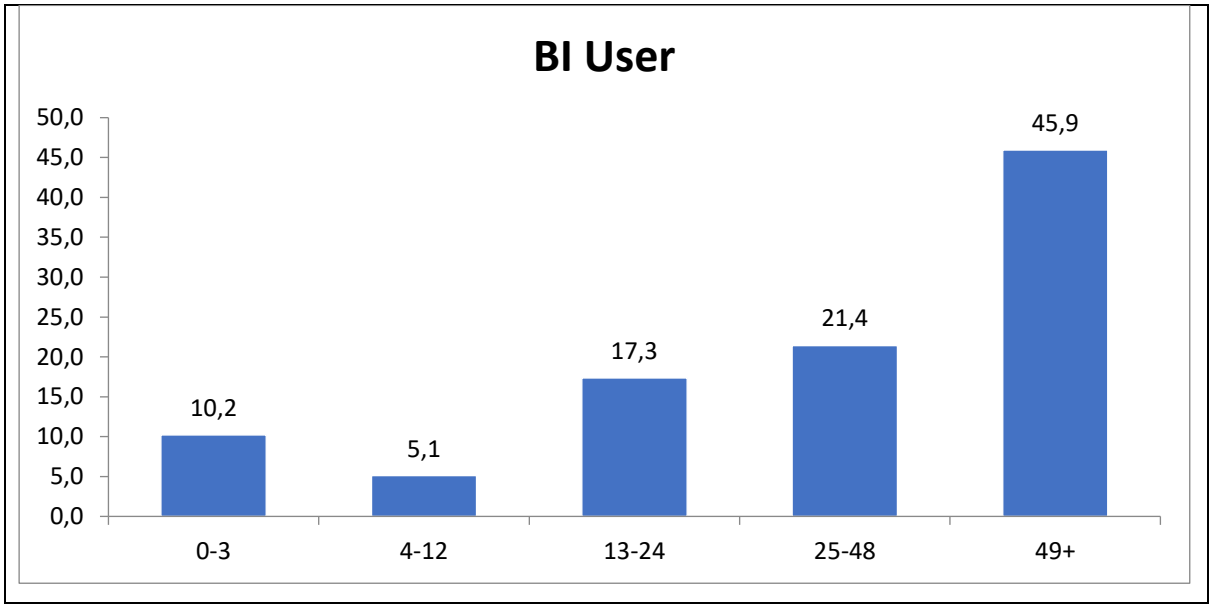

Figure 5: Sample Distribution by BI user experience

Most of the participants (38.8%) have experience with both reports and dashboard BI areas, followed by those with only experience in dashboards BI area (9.2%), followed by those with experience in OLAP cubes, data mining, catalogues, reports, and dashboard BI areas (8.2%), followed by those with experience in reports only (7.1%) as shown in Table 5.4 for further comparisons. Many of the participants (79.6%) have used the BI system, while 13.3% are unsure, and 7.1% have not used the BI system.

i. Descriptive statistics

The mean and standard deviations from the learnability, robustness, design, flexibility, and usability goals are illustrated in Table 3. A Likert scale frequency was used to describe the different variables, where 1 represents r strongly disagree, 2 for disagree, 3 for neutral, 4 for agree, and 5 for strongly agree.

Table 4: Measures of Variability and Measure of Central Tendency

Constructs	N	Minimum	Maximum	Mean	Std.Deviation
Learnability	98	1.00	5.00	3.8878	0.62213
Robustness	98	1.00	5.00	3.6122	0.68312
Design	98	1.00	5.00	3.9252	0.61208
Flexibility	98	1.00	5.00	3.6939	0.67210

Constructs	N	Minimum	Maximum	Mean	Std.Deviation
Usability Goals	98	1.00	5.00	3.9184	0.62234
Valid N (listwise)	98				

Considering Table 3 Measures of Variability and Measure of Central Tendency

- The mean for learnability is 3.8878. This means that most of the sampled population rated the learnability of the reports above average. Furthermore, this indicates that their prior knowledge of banking reports helped them to use the report.
- The mean for robustness is 3.6122. This means that most of the sampled population agrees that it was easy to recover the work from an unexpected situation, e.g., a power cut and that it is easy to take corrective actions (e.g., undo) once the error has been recognised, the report site provides feedback to indicate continued progress.
- The mean for design is 3.9252. This means that most of the sampled population agrees that the report design shows the relevant information and functionalities and provides informative responses to the user.
- The mean for flexibility is 3.6939. This means that most of the sampled population agrees that the user can customize the report according to their priorities.
- The mean for usability goals is 3.9184. This means that most of the sampled population agrees that the report provides the user with the information they require to achieve their goals and that the report aids the user in completing their tasks on time.

In summary, all the values become 4 when rounded to the nearest integer. Therefore, the findings indicate no significant dissatisfaction with the usability of the BI banking reports as measured by these constructs.

ii. Correlations

For this study, $P<0.05$ was considered statistically significant, as advocated by Eze et al. (2019) and Pandya et al. (2016). All the constructs and their relationship have a p-value of <0.05, which means that the correlation between the constructs were highly significant, except for learnability and flexibility which had a p-value of 0.005, which indicates a significant correlation. Table 4 presents the correlations. The findings confirm that all the variables are correlated, this may suggest that they all contribute to the usability of the BI banking reports, but more confirmation is necessary. The findings also confirms that the changes in one construct affects the change in the other, and that the constructs are all related.

Table 5: Correlations

Constructs		Learnability	Robustness	Design	Flexibility	Usability
Learnability	r	1	.430**	.615**	.279**	547**
	Sig. (2-tailed) (p)		0.000	0.000	0.005	0.000
Robustness	Pearson's Correlation (r)	.430**	1	.415**	.405**	.477**
	Sig. (2-tailed) (p)	0.000		0.000	0.000	0.000
	N	98	98	98	98	98
Design	Pearson's Correlation (r)	.615**	.415**	1	.466**	.721**
	Sig. (2-tailed) (p)	0.000	0.000		0.000	0.000
	N	98	98	98	98	98
Flexibility	Pearson's Correlation (r)	.279**	.405**	.466**	1	.580**
	Sig. (2-tailed) (p)	0.005	0.000	0.000		0.000
	N	98	98	98	98	98

Usability	Pearson's Correlation (r)	.547**	.477**	.721**	.580**	1
	Sig. (2-tailed) (p)	0.000	0.000	0.000	0.000	
	N	98	98	98	98	98
**. Correlation is significant at the *P*<0.05 level (2-tailed).						

To answer the RSQ 3, the researcher did not drop any usability criteria from the LBUC and will utilise the LBUC to evaluate the BI banking reports from the user's perspective (BIBRUCUP) using interviews to do so.

b) CIL Data Extraction

The purpose of the CIL data extraction was to identify the BI banking reports usability issues using thematic analysis.

i) Phase 1: Familiarising with your Data

In this phase the researcher also created a project in *Atlas.ti* and named the project CIL project. The CIL project stored all the project files.

ii) Phase 2: Generating Initial Codes

There were 162 initial codes that have been created for this study in *Atlas.ti*.

iii) Phase 3: Searching for Themes

The researcher utilized the request types that the user can select from to log a request. Table 5 shows the different request types, their descriptions, and their frequency.

Table 6: Summary of the different request types, their descriptions, and their frequency

No	Request Type	Description	Frequency volume
1	Small project	A Small Project refers to a project size category that is allocated when a project that is logged; before a project is allocated a size category, there is a scoping that is required to be done and a presentation from the client explaining their requirement at a high level.	15

No	Request Type	Description	Frequency volume
2	Investigation	The Investigation refers to the situation when the data reflecting on the reports may not be as expected by the client. This can be due to data integrity issues, data issues, etc., examples of an error when the client expect the total number of sales to have increased by 3% however the report shows a spike of 20% increase.	51
3	Change request	Change request refers to when the client wants to change a report already developed and published. The client may want to add a business rule, remove a filter, change the report layout, etc.	69
4	Data extract	The Data extract theme refers to the case when the client requests a once-off data in a form of an MS excel file. In most cases, this is via excel. The clients provide the business rules and the fields they want to see. This type of request is usually a once-off and is often called ad hoc.	50
5	Incident	An Incident is usually logged when an error occurs while the user wants to view a report. Incident refers to an unplanned event that interrupts the users, for example when there is a network outage, and the user cannot access the reports.	13
6	Recurring ad hoc	The Recurring ad hoc theme refers to the situation when a request of the same nature/issue keeps on being logged by the client.	3
7	Large project	A Large Project is a project size category that is allocated when a project is logged. Before a project is allocated size, the is a scoping that is required to be done and a presentation from the client explaining their requirement at a high level.	5
8	Maintenance	The Maintenance theme refers to a maintenance issue, e.g., server-related, and database-related issues. Maintenance refers to ensuring that the applications, such as MS PowerBI, Tableau & MyBI, being used are in good working order. Maintenance needs to be done so that the	4

No	Request Type	Description	Frequency volume
		business as usual does not get impacted, i.e., a business can continue to use the reports without getting any errors.	
9	Scoping	Scoping is done for all new projects that need to be classified according to size category by the committee. A client logs this type of request and then gets allocated to a business analyst who will document this scoping. The level of detail and the client's requirements will help the committee size the project, small, medium, large, and extra-large.	8

The captured codes were allocated to the relevant code groups to be able to create network diagrams. The names for both the network diagrams and code groups are like the names allocated to the document names. This was done to ensure that the codes are allocated to the relevant code group and mapped in the right networks and to ensure the consistency of the network diagrams. For example, for the code group named 'Changed request' there is a corresponding network named 'Changed request' (See Figure 5).

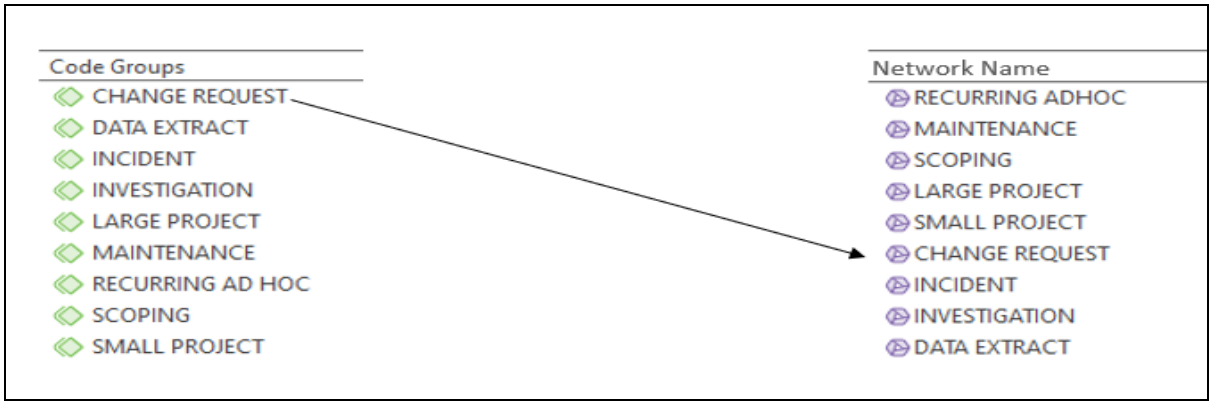

Figure 6: Code group with respective network name

iv) Phase 4: Reviewing Themes

The researcher revisited the codes allocated to each code group and ensured that the relevant codes are allocated to the correct code groups. From the 162 codes that were initially created in Phase 2, 75 codes were retained. The codes that were not directly related to BI banking reports and BI banking reports issues, were removed because these codes were providing general information for the BI banking reports and issues.

v) Phase 5: Defining and Naming Themes

In this phase the thinking behind the code groups were reconsidered based on Phase 1, around the data capturing and familiarisation. The researcher did not change the code groups, they remained as per Phase 4. Figure 6 depicts network diagram in Atlas.ti, showing the nine CIL data themes created in Phase 3.

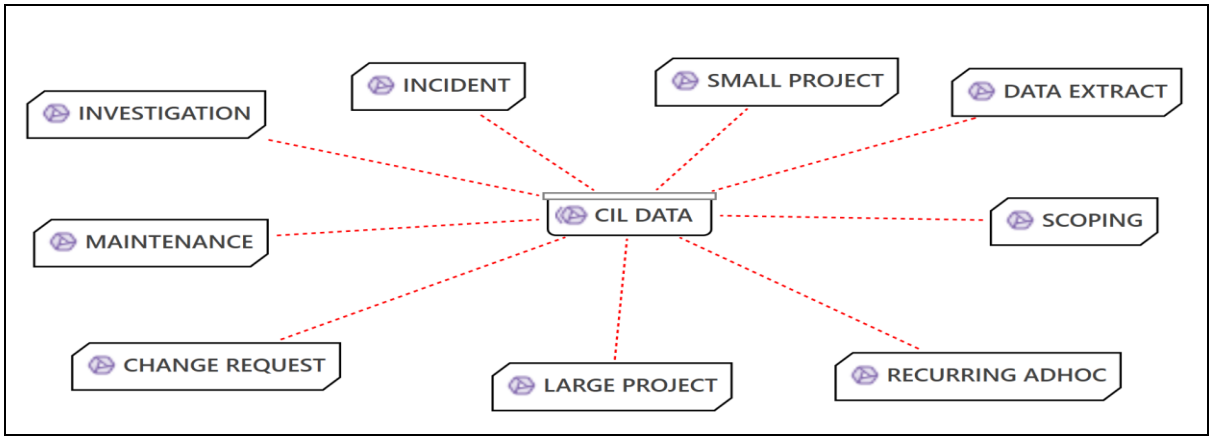

Figure 7: Network Diagram Showing the Themes for CIL Data Extraction

vi) Phase 6: Producing the Report

In this phase, the researcher identified the BI Banking issues for each of the themes created. Table 6 contains the themes created together with their respective BI banking reports issues codes.

Table 7: Themes and respective BI banking reports issues codes

No	Themes	BI banking reports issues codes
1	Recurring ad hoc	Missing Data
2	Maintenance	missing data, system issues, enhancement of reports, and reports investigation
3	Large Project	Enhancement of the Report
4	Scoping	Enhancement of Reports
5	Incident	Missing Data, Data Quality Issues, Investigation of Reports, Slow Speed, Access to Reports, System Issues, and Enhancement of The Reports
6	Data Extract	Missing Data, Enhancement of Reports, reports investigation
7	Small Project	Enhancement of Reports
8	Investigation	Data Quality, Enhancement of the Reports, Missing Data, System Issues, & Access to reports,

9	Change Request	Enhancements of reports, Missing data, Data Quality & System Issues.

- *Missing Data* means that data is missing from the theme's different reports. When there is missing data on the report, this result in the reports not being populated for certain days and the user cannot perform their tasks which then gets delayed until the data is updated on the report.
- *System Issues* means that there was an issue with the system, which caused the reports not being up to date with the data or the user cannot pull or download the report.
- *Enhancements of reports*, where some reports needed to be enhanced to include further requirements such as additional filters, columns, business rules, or data source change, the other reason for an enhancement was that there was a report that the client felt was not satisfied with it and required to be rebuilt for the team to be able to use it. Furthermore, they wanted the reports to align with the similar KPIs they are reporting. This ensures that the reporting numbers are the same across the reports to avoid confusion or misalignment.
- *Report Investigation* was due to the client wanting to ensure that the rules applied for the reports are up to date, and if not, to have the reports updated with the latest business rules, to report on the same numbers for the KPIs.
- *Slow Speed*, where some report was reported to be slow in loading or responding.
- Access to Reports, which resulted from several reports not being accessible on the report portal, and the requestor wanted to understand the cause of the issue.
- *Data Quality*, where some reports required investigation between the front-end and back-end to identify the difference because the volumes on the reports reporting the same KPIs were not the same. These differences caused inconsistencies and some of the values returned where null.

From the BI banking issues code descriptions or details, the researcher identified 10 BI banking reports issues. To answer RSQ 2: ''What are the usability issues of BI reports in the banking industry?'', Table 7 contains the said BI banking reports issues and their respective LBUC. Based on the findings the other LBUC not presented in Table 7 means that their relevance could not be confirm based on the CIL data extraction. Furthermore, since *satisfaction* cannot be measured, this will be included as part of the BIBRUC overall satisfaction of the BI baking reports.

Table 8: BI banking reports issues and their associated banking BI usability criteria (BIBRUC)

No	BI banking report issues descriptions	BIBRUC
1	Up to date reporting (Reports are not up to date)	Task conformance Effectiveness Efficiency Consistency
2	Inconsistency of the data (e.g., null values)	Consistency
3	Misalignment of reporting	Task conformance Consistency
4	Additional of requirements	Task conformance
5	Misalignment of reporting due to incorrect business rules	Task conformance Consistency
6	Back-end and front-end misalignment	Task conformance Effectiveness Mapping
7	The report takes times to load	Responsiveness Efficiency Effectiveness Feedback
8	Inaccessibility of reports	Effectiveness Responsiveness

No	BI banking report issues descriptions	BIBRUC
9	Clear understanding of the report	Task conformance Effectiveness
10	Reports are not usable	Effectiveness Customization

c) Interview results

The purpose of the interviews was to identify the critical usability criteria that should be used to evaluate the BI banking reports from a user's perspective. The interview was conducted after the analysis of the survey data and the CIL data extraction analysis. The survey concluded that there are no BI banking reports usability issues, while the CIL data extraction concluded with 10 BI banking reports usability issues.

i. Age

A total number of 31 interviews were conducted. The interview questions contained a few demographic questions to ensure that the interviewee is not underage, and that they have experience in BI. The age was split into four groups, and there were no responses between the age of 18 to 24 and only 3% of respondents were above the age of 45. The participants between the age of 25 to 34 contained a sample of 48% while the participants between the age of 35 to 44 also contained the sample of 48% too. This means that 96% of the respondents are between the age of 25 and 44. Figure 7 shows sample distribution by age.

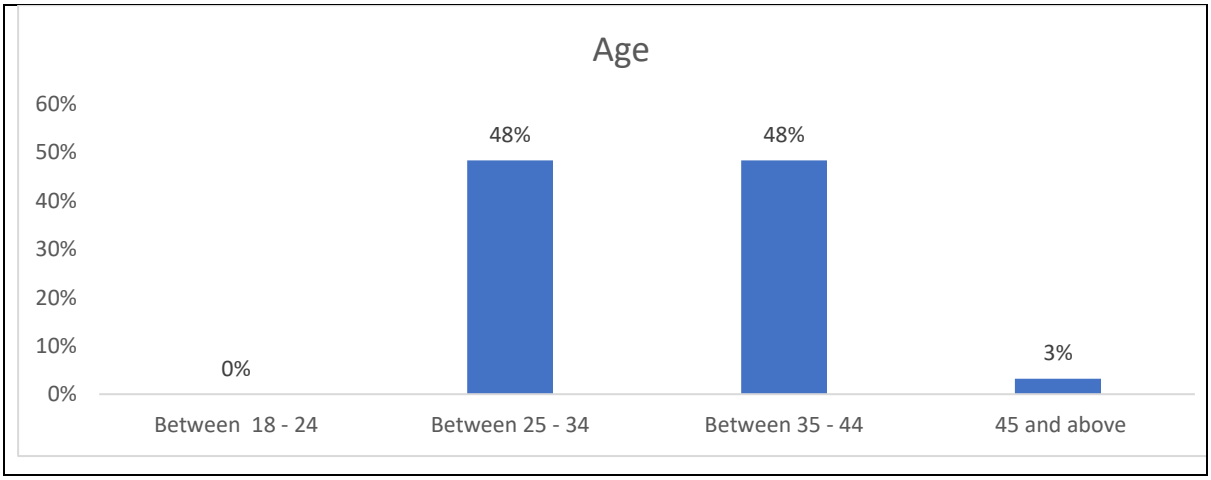

Figure 8: Sample Distribution by Age

ii) Gender

Fifteen (15) males and sixteen (16) females participated in the study. This means that 52% of the participant were females while 48% of the participants were male.

iii) BI System User

This question aimed to check whether the participant had used the BI system before. If participants had no experience with BI, interviews would discontinue. Therefore, all participants in this research and interviews are BI system users (100%).

iv) BI User Experience

Most participants (71%%) have been BI users for 48 or more months, followed by 12 – 24 months as BI users (13%). Both 0 – 3 months and 24-48 months BI users were at 6%, and lastly, followed by 3 -12 months as a BI user (3%). Figure 8 shows the participants' experience as BI users (distribution by BI user experience).

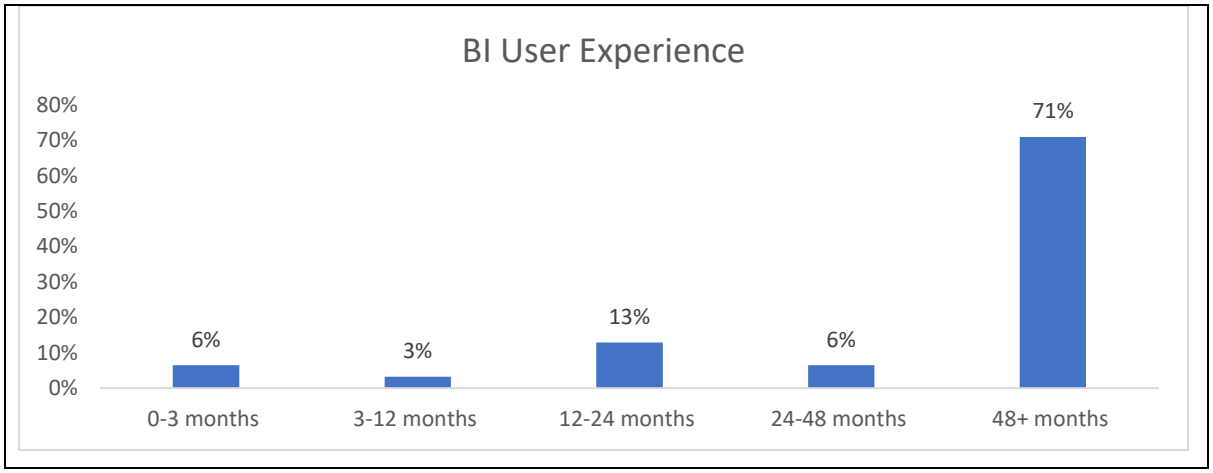

Figure 9: Sample Distribution by BI User Experience

v) Experience in BI Areas

There were five BI areas that the participants were asked to choose from to indicate the area in which they have BI experience in. For this question participants could select more than one option as their BI experience may vary. From the analysis there are 38% of the participants that have experience in the reports and dashboards BI areas, whereas 26% of the participants have experience in all the BI areas. 10% of the participants have experience in both the data mining, reports, and dashboards BI areas, furthermore, 10% of participants also have experience in OLAP cubes, reports, and dashboard. 6% of the participants have experience in dashboards only. 3% of participants have experience in either OLAP cubes, data mining,

reports, and dashboards; OLAP cubes, catalogues, reports, and dashboards; data mining and dashboards; catalogues, reports, and dashboards; as well as OLAP cubes and dashboards BI areas. Figure 9 illustrate the sample population of participants with experience with BI areas.

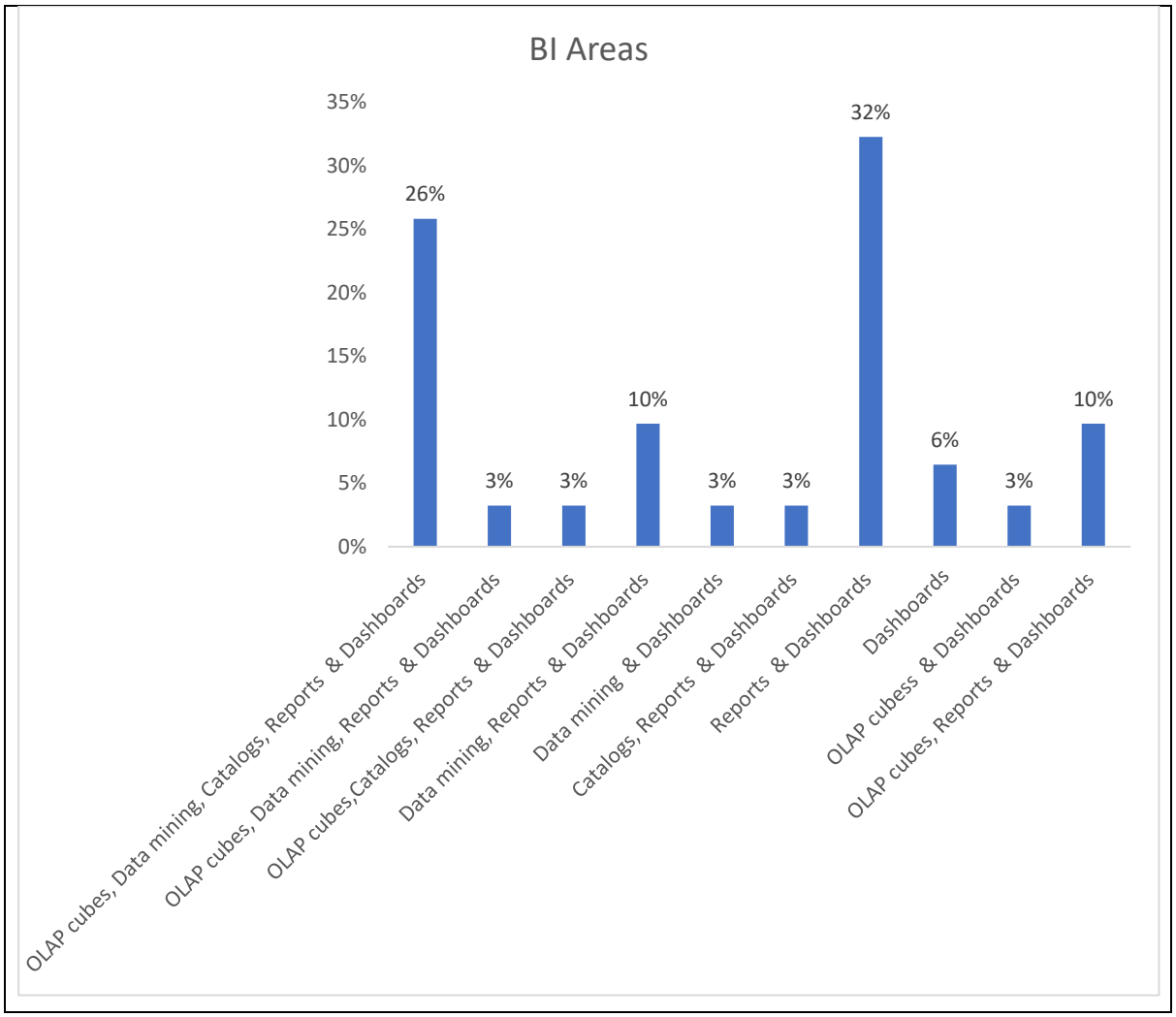

Figure 10: Experience in BI Area

vi) Main interview

The main interview questions resulted in 35 codes relating to BI banking reports issues. This BI banking reports issues were mapped to the BIBRUC AND BIBRUCUP. From the analysis 11 CBIBRUCUP were identified.

Phase 1: Familiarising with your Data

In this phase, the researcher created a new project, and named it Pheladi Interview Project which stored all the project files.

Phase 2: Generating Initial Codes

There were 50 initial codes that have been created for this study in *Atlas.ti*.

Phase 3: Searching for Themes

The researcher utilized the 10 BI banking reports issues identified from the CIL data extraction. Table 7 shows the different BI banking report issues. Similarly, the captured codes were allocated to the relevant code groups to create network diagrams. The names for both the network diagrams and code groups are like the names allocated to the document names. This was done to ensure the consistency of the network diagrams. For example, for the code group named 'The report takes time to load' there is a respective network named similar (See Figure 10).

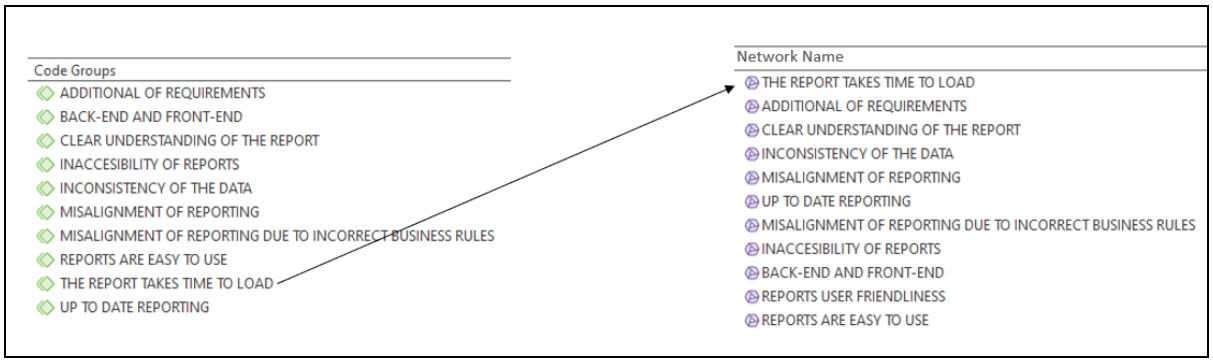

Figure 11: Interview Data Code group with respective network name

Phase 4: Reviewing Themes

The researcher revisited the codes allocated to each code group and ensured that the relevant codes are allocated to the correct code groups. From the 50 codes that were initially created in Phase 2, 35 codes were retained.

Phase 5: Defining and Naming Themes

In this phase the thinking behind the code groups were reconsidered based on Phase 1, around the data capturing and familiarisation. The researcher did not change the code groups, they remained as per Phase 4. Figure 11 depicts network diagram in *Atlas.ti*.

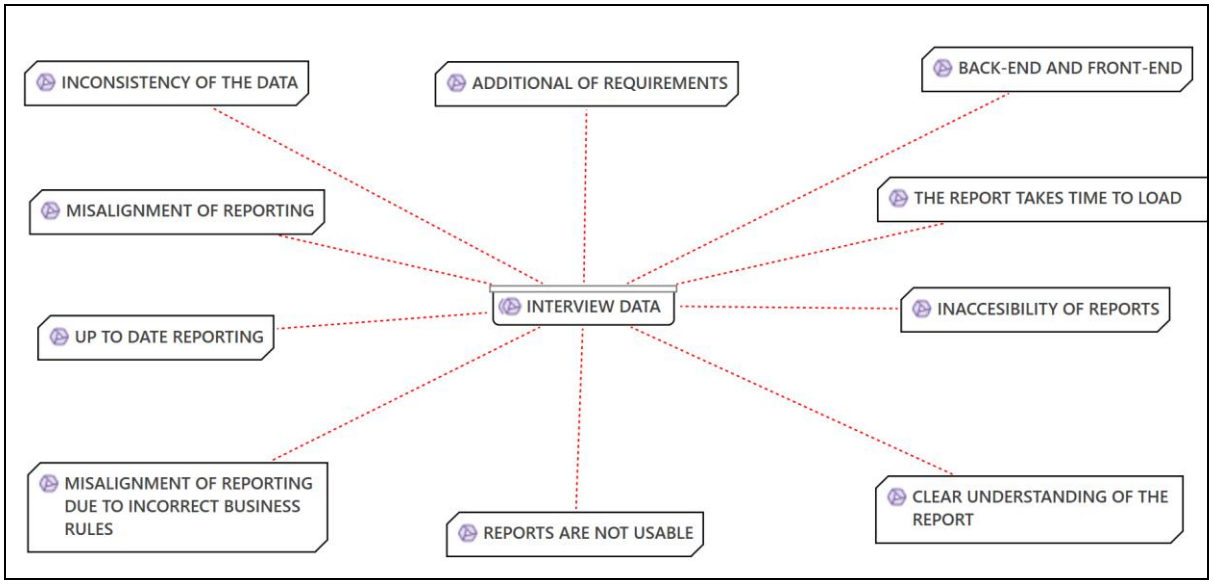

Figure 12: Network Diagram Showing the Themes for CIL Data

Phase 6: Producing the Report

In this phase, the researcher identified the BI Banking issues for each of the themes created and mapped the codes to their respective BIBRUC or BIBRUCUP.

vii) Satisfaction – Yes or No

On the last question during the background questions, the participants were asked if they were satisfied with the BI banking report, the question can be answered with a yes or a no answer as well as the reason to substantiate the answer provided. 77% of the participants answered with a 'Yes', meaning that they were satisfied with the report. Based on this feedback the participants are satisfied with the BI banking reports. 13% of the participants answered with a 'No', meaning they are not satisfied with the BI banking reports. 10% of the participants could not provide a yes or no answered and said that they are not sure as to whether they are satisfied or not.

viii) Satisfaction – scale of 1 to 5

The participants were asked at the end of the interview to provide their overall rating as to whether they are satisfied with the BI banking reports. The participants were allowed to only choose from a scale of 1 to 5, 1 being strongly dissatisfied while 5 being strongly satisfied. For those that responded, 32% of the participants rated their satisfaction a scale of 4, while 19% of the participants rated their satisfaction a scale of 3. 19% of the participants provided a rating of a scale of 3.5 while 19% participants provided a rating of a scale of 5. 3% of the participants

provided a rating of a scale of 4.2, while 19% of the participants provided a rating of a scale of 4.5.

To answer RSQ4: ‘’ What are the critical usability criteria that should be used to evaluate the business intelligence banking reports from the user’s perspective?’’

ix) Triangulation

Figure 12 depicts the results of the data for all the techniques used in this study. The results have been triangulated with the intent to reveal the convergent evidence on the salience of the findings.

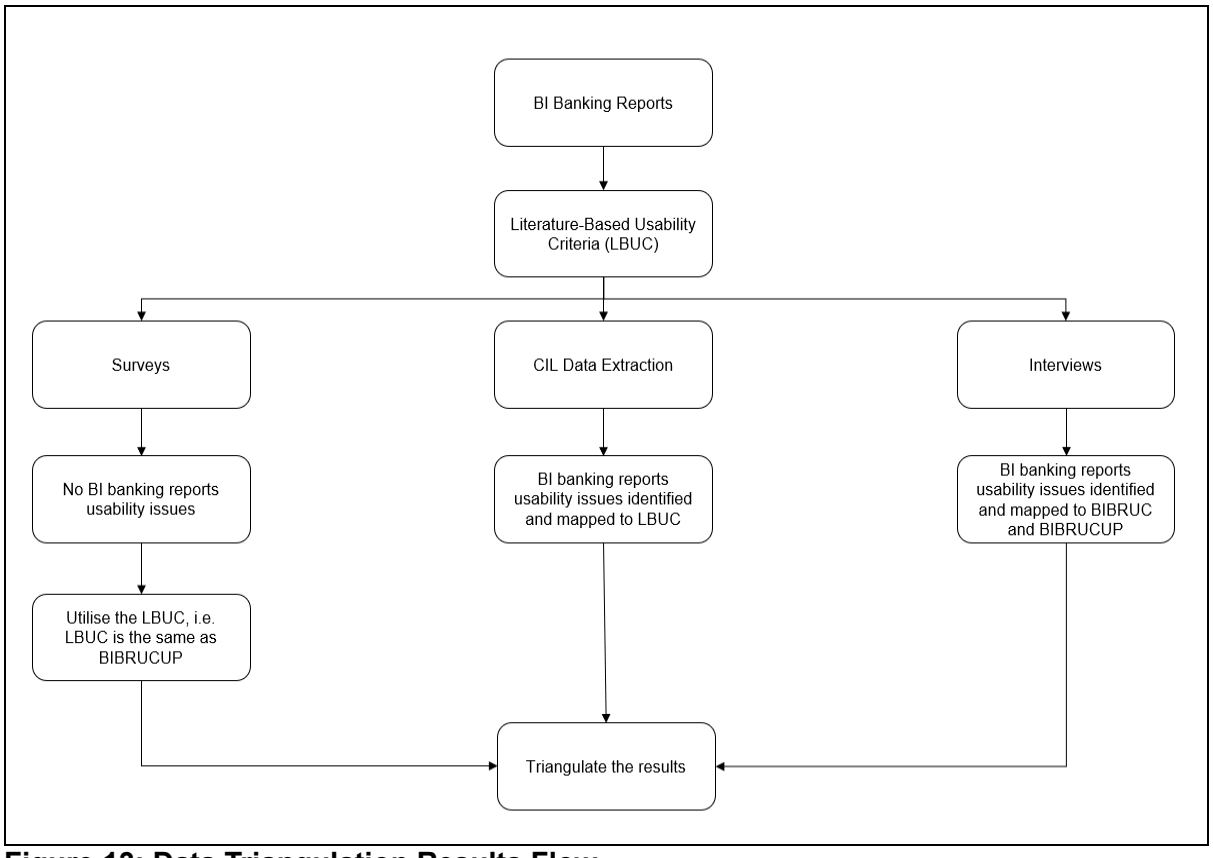

Figure 13: Data Triangulation Results Flow

To answer RSQ4: ‘’ What are the critical usability criteria that should be used to evaluate the business intelligence banking reports from the user’s perspective?’’ Table 8 contains the CBIBRUCUP mapping, which contains the usability category, the LBUC, BIBRUC, BIBRUCUP and CBIBRUCUP. There were 14 LBUC that were deemed relevant for this study, out of the 14, 12 of them were deemed critical for the BI banking reports according to this study. These 12 critical usability criteria are in Table 8. Notably, mapping the BI issues to usability criteria were based on the literature definitions of those criteria but it also involved some subjective decisions. While effectiveness and efficiency influenced most of those issues the purpose was

to see which of the other criteria are relevant. Therefore, the CBIBRUCUP as suggested as a starting point for future research rather than a final and complete set of criteria.

Table 9: CBIBRUCUP Triangulation

No	Category	LBUC	BIBRUCUP	BIBRUC	CBIBRUCUP
1	Learnability	Predictability	X		
2	Learnability	Familiarity	X		X
3	Learnability	Consistency	X	X	X
4	Flexibility	Multi-threading	X		X
5	Flexibility	Customisability	X	X	X
6	Robustness	Recoverability	X		X
7	Robustness	Responsiveness	X	X	X
8	Robustness	Task conformance	X	X	X
9	Usability goals	Effectiveness	X	X	X
10	Usability goals	Efficiency	X	X	X
11	Usability goals	Satisfaction	X	X	X
12	Usability design principles	Visibility	X		X
13	Usability design principles	Feedback	X	X	
14	Usability design principles	Mapping	X	X	X

DISCUSSIONS

The results from the survey and the CIL data extraction where contradictory, and therefore interviews were conducted to confirm if indeed there are BI banking reports usability issues from a user's perspective, to identify the critical usability criteria that should be used to evaluate the BI banking reports. The results confirmed that there are BI banking usability issues. These BI banking reports usability issues were mapped to the BIBRUC and the BIBRUCUP to formulate the final set of usability criteria – CBIBRUCUP.

The triangulation of the findings confirmed the need to incorporate the usability criteria when developing the BI banking reports for the users. The results from the CIL data extraction correspond with the interview results since the BI banking reports issues identified from the CIL data extraction were supported by the interviews, which also provided further BI banking reports issues on a lower level. The usability criteria identified in this study will expand the list of the usability criteria for BI that was identified in the NLR, based on the studies conducted by Eskandari, Clark, and Hamou-Lhadj (2017), Hao, and Jaafar (2011), Chinthakayala et al. (2014), Woskov et al. (2011), Karavite et al. (2018), Town and Thabtah (2019), Smuts et al. (2015), Dyczkowski et al. (2014) and Jooste et al. (2014).

CONCLUSIONS

In this study, we proposed and evaluated the usability criteria for the BI banking reports. Data collection was done through survey, CIL data extraction and interviews. The findings indicated that there are BI banking reports usability issues, therefore, there is a need for usability to be considered when developing the BI banking reports, using the proposed critical usability criteria that has been validated for its appropriateness based on data triangulation. Therefore, the critical usability criteria can be used to evaluate the BI banking reports.

Future studies can investigate the contradictions between CIL data extraction and interviews against survey. Future studies can also focus on more than one bank or the whole bank instead of one business unit, and it would be useful to repeat the same study with them. Similar studiesy can also be conducted with the employment of other data collection techniques, such as focus groups, and observation.

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